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XXXII.

ELECTROSURGERY AS AN AID IN RHINO-
PHARYNGOLOGY.*

LEE COHEN, M. D.,

BALTIMORE.

That electrosurgery has been accepted as an important acquisition by the general surgeon, and by many working in special fields of surgery, is attested by the prominence given it at the clinical congress of the American College of Surgeons in Philadelphia last year. During a conference at that time no less than eleven monographs were presented by surgeons of note, and these have since been published in *Surgery, Gynecology and Obstetrics*, the official journal of the association. In the discussion advantages offered by the electrosurgical unit in almost every domain of general surgery were set forth, and the observers participating unanimously agreed that we have here one of the most valuable contributions to medicine of modern times, and that new indications for its use are being found every day.

In spite of the appearance in the literature of the past four years of many articles on this subject pertaining to our special

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field, comparatively few rhinopharyngologists have embraced this valuable measure. Now that many men in general practice, not too friendly to throat surgery, are much interested and frequently make requests that tonsils of their adult patients be removed with the high frequency machine, and even the public is becoming so educated that patients also request removal of their tonsils by the "new electrical method," we find ourselves compelled to recognize the need for this work. It is, therefore, incumbent upon the rhinopharyngologist to make thorough study of the principles involved in the use of the several different types of high frequency currents, in order that he may properly evaluate effects and may apply the type best suited to his needs.

It is not within the province of this discussion, nor will time permit us to go into the physics of the high frequency currents. These can best be studied in textbooks devoted to the subject, and in some of the excellent monographs to be found in the literature. However, that a thorough knowledge of the physical effects of the various currents is a prerequisite to the safe and intelligent use of electrosurgery goes without saying, for application in the hands of the unskilled may do great harm, and also bring the method into disrepute. Likewise, only those well trained in the anatomy and surgery of our field should ever attempt electrosurgery.

After an experience of four years your essayist is convinced that there is a real place in our specialty for this valuable adjunct to surgery, but while in selected cases we have found it the method of choice, we are far from willing to follow those enthusiasts who relegate long accepted surgical methods entirely to the past in some fields of our endeavor—notably in removal of tonsils.

Many conflicting views are still held as to the value of electrosurgery in complete removal of the tonsils. Some try the method without first understanding the effects of the current or without sufficiently mastering its technic, meet with disappointing consequences and unsatisfactory results, and then not only give up the method but speak ill of it; others flatly state that they do not believe in this method for tonsillectomy. Those, however, who have made a study of the currents, and who have been willing to spend sufficient time in experimenting with them, have shown

by their results that the tonsil can be just as effectively removed with the high frequency current as with any other surgical method.

We are convinced that in children surgical removal still holds first place, as one operation ends the entire procedure. In trying out the method in a few cases of children, about ten years of age, we found it impractical, because of lack of co-operation and their unwillingness to return for a second application. In these few cases we were obliged subsequently to etherize the children and remove the remainder of the tonsils in the regular way.

Also healthy adults, up to middle age, who are good surgical risks and who do not mind giving up a week or ten days from their usual routine, will be best served, I believe, by surgical removal in the hospital, either under local or general anesthesia.

It is a well known fact, however, that many patients with diseased tonsils cannot be subjected to surgical operations on account of fear, age or some condition rendering them more liable to surgical shock than the average person. In the aged up to seventy-five, in the presence of tuberculosis, organic heart disease, nephritis—with or without marked hypertension—and, in fact, when any condition exists contraindicating surgical methods, we have had most satisfactory results from the high frequency current.

All our cases are treated as ambulatory and under local anesthesia—a decided advantage to those individuals in such employment that they cannot lose even a day from their posts. It is true that some soreness of the throat follows, but not sufficient to hamper them in eating or drinking. Nor is this soreness accompanied by the rise of temperature, malaise or depression which is usually more or less evident after surgical removal of the tonsils. Owing to closing of the lymphatics by the coagulating current, absorption does not occur in these cases.

Our oldest subject to date was 65 years of age, and among these older subjects we have numbered many with angina pectoris, organic murmurs, nephritis, etc. None of these has suffered in the least from shock or other depressing effects. The patient just mentioned (age 65 years), who was thought to have

had true angina, was treated over three years ago. Since then she has gained in weight, has so improved physically as to be able to make two European voyages, and since the removal of her tonsils has not had a single pseudo-angina attack.

Patients from neighboring states or cities, who come for this work, remain in the hotel over night after treatment, return home the next day, and come back a week or ten days later for the next application.

The high frequency current is especially useful in the removal of rests of tonsil remaining in the supratonsillar region or down near the base of the tongue following incomplete surgical extirpation, and also in getting rid of lymphoid tissue which, much to our chagrin, often appears in the fossa after our best efforts in tonsillectomy. In these cases one application often suffices to rid us of such small masses.

Hemorrhage does not occur primarily but may do so secondarily. We have seen secondary bleeding in three cases, but never of sufficient quantity to cause worry, and these were controlled generally by the use of a simple peroxide gargle or by moderate pressure with tonsil sponge for five or ten minutes. One case, however—the third operated upon by us, over four years ago—who had a small mass of tonsil near the base of the tongue, bled so profusely that we were obliged to send her to the hospital, fearing a blood transfusion might be necessary. We are certain that in this patient, owing to early lack of experience, either too dense a current was used, or by too long an exposure to the current part of the wall of a blood vessel was destroyed, bleeding occurring later with the separation of the slough. With a greater experience in the use of our current and in the proper direction of the needle we have had no such repetition.

Type of Current Employed.—The cutting, dessicating and coagulation currents all have their place in rhinopharyngology.

A few observers, notably Clarke, whom we all recognize as a pioneer and master in this field, prefer the dessicating current in tonsil work. Whether because of our technic or of the apparatus we use, I cannot say, but our experience with it has been somewhat unsatisfactory; much more time is required to destroy the

tonsil in the moist field within the throat, and we have found secondary bleeding more likely to follow its use.

Thompson³ uses the cutting current, and, with an insulated snare, removes both tonsils en masse at one sitting. To our minds this offers no advantage over the regular surgical operation for their removal, and must be accompanied with the same shock and other incapacitating effects. The greater number of operators, including ourselves, employ the coagulating current, placing the large inactive electrode on the back, the front of the neck or forearm. Doane⁴ uses either a ring or half ring, placed about the tonsil, as the inactive electrode, and claims the advantage of a quicker operation and use of much weaker current.

Most operators use for the active electrode steel needles bent at right angles, three-sixteenths to one-quarter inch from the point, such as those advocated by Dillinger,^{5,6} and Silvers.⁷ The needle shaft should be insulated from its connection in a hard rubber handle up to the right angle bend near the point, thus preventing jumping of the current to other parts of the mouth and pharynx.

The number of treatments required for the complete removal of the tonsils varies in the hands of different operators. Millstone⁸ removes both tonsils completely at one sitting. Our experience would make us fearful of this method. The pain following such a procedure plainly must incapacitate the patient and danger of secondary hemorrhage be greatly increased. Besides we could not feel certain of always having reached every vestige of tonsil tissue in the depth of the fossa. Some prefer three applications for each tonsil, and I know of others who use even seven or eight sittings for each tonsil. Our own technic closely resembles that described by Dillinger, but our method of anesthesia is entirely different.

To the right tonsil region and fauces a topical application is made of a 2 per cent solution of nupercain (Ciba), which we find far more effective, much quicker in action and less toxic than cocaine. Five minutes later a 5 cc. ampule of 1 x 1000 nupercain is injected about the tonsil, as in any other local tonsil operation. Avoid producing edema by injecting in and about the pillars, as this will greatly obscure the field. After seven minutes the

operator proceeds with the certainty that the patient will feel no pain whatever.

Much has been written about the painlessness of this work when only topical applications of cocain have been made. In the beginning we used every endeavor, by means of the topical application, to secure sufficient anesthesia, but without exception patients complained bitterly of pain during the operation, and many were unwilling to go on with second treatment unless some means of relief were found. Injection of novocain, first tried, did not produce sufficient anesthesia. The injection of nupercain (Ciba), as mentioned, was found to perfectly fill our needs.

With the large inactive electrode beneath the back of the patient, in a semi-reclining position on the operating table or chair, the active current is delivered by means of the needle. The needle is made to penetrate the tonsil tissue to a depth decided upon by first measuring with the needle, before turning on the current, the thickness of the tonsil from its inner face to the basement membrane, being careful not to approach with the needle point nearer than three-sixteenths inch to the basement membrane, lest coagulation occurs beyond this membrane into tissues of the neck. Should swelling of the neck occur subsequently, we have an indication that the current penetrated too deeply.

From ten to fifteen such punctures, one-quarter inch apart, are required to cover the entire tonsil. After placing the needle where desired, the current, controlled by a foot switch, is turned on and allowed to act from one or three seconds, or until a white ring of coagulation about one-fourth inch in diameter forms around the needle. Too long an application chars the tissue and interferes with reaching the deeper parts. Care must be taken to avoid injury to the tongue, when nearing the lower tonsillar pole, and to the anterior or posterior pillars, for if these structures are damaged not only is the after pain greatly increased but secondary hemorrhage much more likely to occur. Such injuries are best avoided by so introducing the needle that it points away from the pillars, on the one hand, and is directed upward from the tongue, on the other.

When operating on small shallow tonsils or removing small pieces remaining after former surgical removal, it is well to stick the needle *not* straight into the tissue but almost in a horizontal direction, just above the basement membrane. Then pull the tonsil mass toward the center of the throat, and at the same time turn the needle point toward the exposed surface of the tonsil, so that the most intense heat which emanates from the point of the needle will be directed away from the basement membrane.

By similar technic, with the point of the needle turned away from the anterior and posterior pillars, when destroying tissue adjacent to them, injury to the pillars is avoided.

Pain immediately following the application is not great, and many patients go to their work at once. Others go shopping or to moving pictures. Several hours later, around bedtime, pain in some cases is greater and such patients may require codeine for sleeping.

After treatment consists in use of a warm saline gargle after meals and before retiring, and some few nervous persons who complain of more discomfort make use of the throat ice bag. In no instance, however, can the discomfort compare with that felt after the regular tonsillectomy.

One week after the right tonsil is thus treated, the same procedure is used on the left, as by that time little or no discomfort is complained of from the right side. In still another week slough on the right side has entirely disappeared, and one sees a fossa of practically normal color, in which also may be seen tonsil tissue here and there. Again this side is anesthetized and these bits of tissue destroyed. The thickness of these small islands of tissue must again be measured with the needle before turning on the current. The shallow ones may be destroyed by rubbing the flat surface of the needle over them while the current is on, almost as if one were gently curetting the surface, while for those with greater depth the "puncture on the flat and turning of the point" procedure may be employed. Finally, one week later, or three weeks after the first treatment of the right tonsil, the remains of the left may be destroyed.

Thus four treatments, two to each tonsil, have been sufficient in all but a few instances where the tonsils were extremely large

and fibrous. In these cases we found a few high spots which required touching up, once on either one or both sides at the same sitting.

Nasopharyngeal atresia, recognized as one of the most difficult conditions for surgical correction, offers another fruitful field for electrosurgery. Mackenty, in a recent article, truly states that "the many procedures advocated for the cure of nasopharyngeal atresia bear witness to the inadequacy of all, and to the extreme difficulty in the way of even a moderate degree of accomplishment."

E. T. H., white, male, 30 years of age, consulted us May 14, 1927. Eleven years prior to this date, following the removal of tonsils and adenoids, a severe infection of the throat and nose took place, accompanied by a facial erysipelas. For some weeks his life was despaired of, and when he finally recovered, a complete nasopharyngeal atresia had resulted. During the following seven years four distinct ineffective surgical operations were performed by two different surgeons for its relief. When first seen by us the posterior pharyngeal wall was, as a result of previous surgery, a mass of scar tissue, to which the soft palate was bound down in its entirety. Not even the usual small central hole through which a probe could be passed was present.

Realizing that further surgical attempt offered very little hope for success, in the presence of so much scar tissue, we decided to make use of electrosurgery, which had been successfully used by Bourgevis and Poyet in 1914 and 1919. They used the coagulating current with graduated olives and angular knives, requiring four or five treatments. We mapped out the following plan, however, operating October 24, 1927:

Under local anesthesia (instillation of 3 per cent alypin sol. through the nose into the nasopharynx by means of a spray, and deep novocain injections from below with a long angular needle), a very large aneurism needle, armed with a heavy Pagenstecher carrier, was introduced from below upward, through the extreme outer limit of the palatal attachment to the posterior pharyngeal wall, on the left side, until the point came in contact with the base of the skull. The needle was then so turned that the point

might pass from above downward, through the extreme right side attachment of the adhesion. When the point reached the oropharynx the carrier was pulled through and the needle withdrawn. A piece of heavy silver wire, 20 inches long, was now drawn up through the right side, across the nasopharynx, and down through the left side, so that both its ends could be brought out through the mouth. These two ends were then threaded through the cannula of a long insulated snare connected with the active pole of a high frequency unit and made fast.

The cutting current was now turned on, and with a rather quick closure of the snare, the intervening attachment of the soft palate to the posterior pharyngeal wall cut through, without the least bleeding. Silver wire was used in place of steel, because its greater flexibility enabled us, by keeping the end of the snare in contact with the posterior pharyngeal wall, to sever the palatal attachment directly in the line of adhesion, without damage to the soft palate. By means of the glove covered index finger, it was then found that the postnasal space was almost completely filled with scar tissue. We proceeded to destroy this scar tissue as thoroughly as possible with the coagulating current, applied with the regular tonsil needle, pulling the palate forward with a hard rubber retractor. In addition, the apposing surfaces of the soft palate and posterior pharyngeal wall were lightly seared with the monopolar or desiccating current. By this last procedure it was hoped to cover these surfaces with a dry eschar, which might prevent recurrence of the adhesion until healing took place, and our efforts met with complete success. You will note that in this case all three types of current were used.

Reaction following this procedure was quite intense and necessitated keeping our patient in the hospital ten days. Three days after operation, incision of left membrana tympani, because of otitis media, was required, and there was a slight oozing of blood from the desiccated surfaces. However, bleeding had entirely subsided by the following morning, and except for an occasional show of blood, gave no further annoyance. The ear discharge ceased in about a week, without complication, and in another week's time the nasal breathing was found to be most gratifying. With further disappearance of swelling, breathing improved still

more, and there was a very satisfactory space in the nasopharynx, as seen by the postnasal mirror.

About two months later (December 5th) the patient was returned to the hospital for the destruction of a small amount of scar tissue remaining in the nasopharynx. This we also accomplished by electrocoagulation. Two days later left otitis media again required incision of the drum, but the ear ceased discharging in four days. Though there was a slight tendency toward contraction of the opening into the nasopharynx, which was controlled by dilatation with a tracheal dilator at intervals of about six weeks, there was not the slightest recurrence of adhesion between the soft palate and pharynx.

This patient was last seen in December, 1930. He left us with a patent opening of natural size between the oropharynx and nose, through which he breathed with perfect comfort. Also the palatal arch remained mobile and functioned normally. Without the aid of electrosurgery, we are certain that, owing to the scar tissue present, this patient could never have found relief.

In the *nose*, because of its narrow space and possible jumping of the spark to other parts than those we wish to attack, the greatest care in the use of the high frequency current must be exercised.

Dessication has been very successfully employed in removal of angioma within the nose and has been advocated for the destruction of vessels in the cartilaginous septum, which are the seat of recurrent bleedings; but in the latter, after trial, we believe that the galvanocautery still holds first place. Beck¹¹ reports successful use of the coagulation current intramurally for reduction of intumescent and hypertrophied lower turbinates.

Malignant growths in the antrum have been successfully treated with the coagulating current by Clark and others.

We have been successful with the dessicating current in preventing recurrence of fibropolypi and granulation tissue in a number of cases of chronic hyperplastic ethmoiditis which had resisted all other means at our disposal. In this situation we must be most guarded in its application. We make use of a straight needle, insulated to within one-eighth inch of the point, and

lightly sear the surface from which the polypi had sprung, with a mild dessicating current. Not more than two applications have been necessary in any case.

In the larynx electrosurgery has been effectively used by Lynch¹² in four cases of early carcinoma involving the vocal cords, without a thyrotomy. In this connection the suspension apparatus was used as an aid. Lynch also reports in the same discussion destruction of carcinoma of the tonsil and soft palate by the coagulating current, without a recurrence two years and eight months after operation, and two cases of carcinoma of the base of the tongue. In papilloma of the larynx, reports of results of fulguration, or the dessicating current, have thus far not been so encouraging.

Recently Hurd¹³ has reported good effects in ear conditions, through the destruction of lymphoid tissue and adhesions in and about the fossa of Rosenmüller, with the coagulating current.

In conclusion, we believe that, owing to its safety in trained hands, the absence of shock and comparatively slight pain and reaction following its use, as well as its economic advantages, the value of electrosurgery in rhinopharyngology will be more widely recognized and it will be more extensively used as time goes on.

1820 EUTAW PL.

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XXXIII.

CAVERNOUS SINUS THROMBOSIS: RECOVERY.*

EUGENE R. LEWIS, M. D.,

LOS ANGELES.

The first postmortem description of cavernous sinus thrombosis I have found is that of Abercrombie in 1818, published in "Diseases of the Brain." Statistical evidence as to incidence is extremely vague. De Grósz reports "only a few cases" presented at the University Eye Hospital, Budapest, among over half a million patients during the first quarter of the present century. From the Pathologic-Anatomic Institute of Debrecen, Nagy reports four cases examined postmortem within one year following meibomian infection. This difference of (conservatively) many hundredfold in the incidence of this comparatively rare condition cannot but suggest etiologic possibilities of some peculiarly local nature. Smith reviewed the literature of 140 cases and reported five cases (*Archives of Ophthalmology*, 1918); his analysis revealed otologic origin, 40 per cent; orbit and face, 35 per cent; mouth and throat, 13 per cent; nose, 9 per cent; others, 3 per cent. He says nothing concerning incidence or mortality. Butler reports one case which recovered and states that 7 per cent of cases of cavernous sinus thrombosis recover spontaneously, though he failed to state authority for this figure. Individual case reports by Eagleton, Hays and others contain no statistical data.

Diagnosis is discussed extensively by Parsons, De Grósz and Faulkner (Trans. Clin. Cong. Surg., 1930). Differentiation must be made between cavernous sinus thrombosis and (1) orbital abscess, (2) ethmoid abscess, (3) frontal sinus abscess, (4) periorbital phlegmon. It is further necessary to differentiate infectious or thrombotic processes of other cranial sinuses, particularly the lateral and petrosal sinuses, and to recognize their

*Presented at the annual clinical meeting of the Los Angeles Ophthalmological and Oto-Laryngological Society, April 6, 1931.

association with such involvements of the cavernous sinus. I believe that emphasis may be laid upon the following diagnostic points:

A. Initial etiologic process of traumatic or infectious nature in one of four areas:

1. Area drained by angular, supraorbital or supratrochlear veins.
2. Area drained by ethmoid or sphenoid veins.
3. Area drained by pterygoid plexus.
4. Area drained by lateral and petrosal sinuses.

B. Local and remote signs of extension of initial etiologic process: Local—Pain, tenderness, heat, swelling and congestion. Remote—Upper lid chemosis and actual exophthalmos impairing ocular movements, meningeal symptoms, leucocytosis, bacteremia, chill, fever; frequently but not invariably fullness of retinal veins and optic disc signs of retrobulbar neuritis; oculomotor paralyses involving third and fourth in addition to sixth nerves; other cranial nerve impairments, first, second, upper division of fifth, seventh and eighth; altered cerebrospinal pressure and fluid.

I have had two other cases of infectious cavernous sinus thrombosis, both following acute infectious lesions in the drainage area of the angular vein; one died on the tenth day following onset of febrile symptoms and autopsy revealed mural thrombosis of the cavernous sinus, obturating thrombus of the anterior group of veins and diffuse plastic basal meningitis; the other case became afebrile after several very stormy weeks during which visual and other cranial nerve functions suffered severe impairments. About three months after subsidence of initial febrile reaction she developed acute exacerbation of meningeal and encephalitic symptoms, dying in five days. Postmortem examination showed organized clot within the cavernous sinus, pus and extensive organized exudate over the entire base of the brain but no encephalitis or abscess.

Fulminating destructive infectious process involving the sphenoid, ethmoid, frontal and orbital tissues may simulate the earlier stages of cavernous thrombosis, but the eventuations of three to

five days may be expected to clear up the diagnosis. There is nothing to be lost by waiting in these obscure stages, whereas much or all may be lost by premature surgery. Spontaneous rupture of nasal sinus or orbital abscess, or definite softening and pointing in due course of time under general systemic fluid alkalization, local thermotherapy and careful observation will reveal the diagnosis within a week or less, during which delimitation of the local process, protective organization of circum-inflammatory exudate and increased general and local resistance will add immeasurably to the chances for recovery.

Ligation of veins from the initial infected area, transfusion of blood from immunized donors, carotid ligation, and, in cases originating in tympanomastoid areas, lateral sinus operation have been advocated for definitely diagnosed cavernous sinus thrombosis; also exenteration of the orbit and direct drainage of the cavernous sinus. The anatomic impossibilities of satisfactory surgical attack should be sufficient to contraindicate it.

The use of bacteriophage or of intravenous mercurochrome is worthy of consideration. In my opinion, the greatest prospective value to the patient attaches to intensive and unremitting devotion to general systemic supportive and detoxicating measures, in the effort to attain the greatest possible protective tissue reactions and the utmost protection against local traumatism during the critical period of the process.

Rudolph Schmidt, German parentage, age 15. Family history not significant; personal history, well and strong, no special illness. The last week of October, 1930, developed a "boil" or "large pimple" on left cheek, near angle of mouth; this was incised by Dr. A., following which the cheek became swollen and painful. Dr. B. was seen and further incisions were made. Infectious cellulitis progressed, involving face, eyelids, scalp and retroauricular cervical regions. The fifth day he was so sick hospitalization was necessary. At the Hollywood Hospital blood examination reported staphylococcus aureus; red cells, leucocytes and albumin in urine; no leucocyte or erythrocyte count made. The patient was given bacteriophage intravenously. Transferred to Los Angeles General Hospital November 18th, unconscious. Temperature 103, later 104; 34,000 leucocytes, 94 per cent polys.

Spinal fluid 60 cells, neck stiff, both eyeballs proptosed and intense chemosis of conjunctivæ and lids. Diagnosis: Cavernous sinus thrombosis. Examination incomplete, as early fatal termination expected.

Dr. Lewis saw him November 21st, but inspection only—notes “apparently moribund, partially conscious, both eyeballs proptosed—almost complete ophthalmoplegia, O_2 ”. November 24th, conscious, neck markedly stiff, not in pain but generally hyperesthetic; especial sensitiveness in upper cheek and forehead— $R > L$; also areas on arms, body and legs; complete VI paralysis R. and L.; all eye movements greatly impaired; extreme chemosis and proptosis of eyeballs; O. D., central vision good, O. S., blind; media clear; O. D., disc outlines sharp, deep red, cup details obscured, no gross vascular changes; O. S., disc margins unclear, cup details obscured, peripapillary grayish exudate, no vascular lesions; anosmia? Manifest affection of II. R. and L., III, IV, VI R. and L., V upper div. R., VII R. (facial lag), VIII cochlear and possibly vestibular; peculiar personality reactions—pettishness, apprehensions, nonco-operative. Called Dr. Ingham and Dr. Neilson.

Diagnosis: (1) Acute infection in drainage area of facial and angular vein. (2) Incision of this lesion—repeated 48 hours later more extensively. (3) Prompt extension of process, cellulitis, febrile symptoms, toxemia. (4) Intracranial symptoms of cerebral and spinal meningeal irritation, vascular blocking, $\frac{1}{2}$ " proptosis of eyeballs, chemosis of upper lids and neighboring areas; acute retrobulbar nerve affections, other cranial nerve affections; disturbed forebrain functions; leucocytosis, turbid spinal fluid with high cell count; later hyperthermia (?); basal meningitis, bulimia, dermatographia, profound personality changes. (5) Clinical regression with gradual function improvements, personality restoration; regain of lost weight; cranial nerve function, partial recoveries II, III, IV, V, VI, VII, VIII.

Subsequent history: Temperature ranged from 101 to 104 through November; opisthotonos, exophthalmos, chemosis and exquisite hypersensitiveness, dermatographia gradually subsided; personality peculiarities persisted; bulimia and garrulous

tendencies prominent during last week of November and first week of December; high fever, suggestive of central hyperthermia. Spinal fluid in December showed 300 cells, 200 cells, 200 cells. Between Christmas and New Year's, beginning return of function became manifest in sixth nerves, more marked in right. Leucocytosis remained between 10,000 and 20,000 until January, then gradually subsided to normal. Gradual return to normal personality, appetite and rest periods during January. Gained twelve pounds between December 15th and February 21st. Locomotion was quite difficult when he first began to move about February 1st; in the course of a week or so he was able to walk fairly. Vestibular examinations in January and February revealed perverted reactions R. and L., significant of supratentorial extensive lesions; cochlear examination showed definite perception impairments R. and L., suggestive of central lesion.

Neurologic findings by Dr. Ingham and Dr. Neilson:

Dr. Neilson: "Saw him on November 25th and noted 'apparently moribund, partially conscious, both eyeballs proptosed, almost complete bilateral ophthalmoplegia.' But when I again saw him, on the sixth day in the hospital, he was conscious and not in pain, but he was generally hyperesthetic, especially in upper cheeks and forehead, more on the right than the left. There were also hyperesthetic areas on arms and legs. Complete paralysis of both abducens nerves was present, but the remainder was difficult to evaluate because of marked impairment of all eye movements due to proptosis and chemosis. Vision was good on the right but was lost on the left. The media was clear and the right disc outline was sharp, deep red, but the cup details were obscured. There were no gross vascular changes. On the left the disc margins were unclear, cup details obscured and there was a peripapillary exudate but no vascular lesions seen. Anosmia was thought to be present."

Dr. Ingham saw him December 3rd and recommended transfer to neurologic service with a diagnosis of meningitis with multiple cranial nerve damage secondary to cellulitis of the face. While patient was still unconscious a spinal puncture was done. This showed 750 cells per cu. mm., of which 80 per cent were polymorphs.

On December 8th, a neurologic examination gave the following: Universal tenderness, such as seen in cerebrospinal meningitis or the meningeal form of poliomyelitis, a cloudy mental state, but co-operation was obtained for a partial examination. The patient would not permit his eyes to be touched. Marked edema of the orbits was present. There was an apparently complete optic atrophy on the left, but in testing the fields light perception in a small portion of the left temporal field was found. Vision on the right was apparently unimpaired. The right pupil reacted well except consensually, while the left reacted well consensually but not to direct light or on convergence. There was a bilateral sixth nerve lesion and parts of the third on both sides. There was a ptosis of both bulbi, more on the right. There were a Babinski on the left, a bilateral Kernig response and normal abdominal reflexes. Rigidity of the neck was marked. The diagnosis entered was: "Diffuse infection beginning as cellulitis of the face, spreading to meninges with basilar meningitis, now recovering. There probably has been a cavernous sinus thrombosis."

On January 16th, a spinal puncture showed 1,700 cells per cu. mm., of which 80 per cent were polymorphs; 15 cc. of 1 per cent mercurochrome was given intravenously. After this, through February, three other spinal punctures were done, which showed a constant subsidence of the cells and a gradual clearing of the fluid. Many more spinal punctures were ordered, but because of flat refusal on the part of the patient, even after $\frac{1}{4}$ gr. of morphin by hypodermic, only occasionally was the fluid obtained.

A neurologic check-up on March 16th showed the following residuals still present, but all evidence of activity was gone: "Total blindness left with complete optic atrophy and the resultant pupillary changes. (Both pupils now reacted well on convergence.) Slight ptosis of right eyelid. The left sixth nerve was weak. The deep reflexes of the upper extremities were active but not spastic; those of the lower extremities were spastic. There were positive Babinski, Chaddock and Gordon reflexes on the left. Otherwise he was normal."

Vestibular examination in April showed marked central impairments characteristic of supratentorial lesions; weight increase

from Thanksgiving, 15 pounds. Left eye totally blind; both discs show signs of retrobulbar lesions—without vascular changes.

This patient has recovered after extensive infectious thrombosis of cavernous sinus, staphylococcus aureus bacteremia, toxic encephalitis, extensive acute cranial and spinal meningitic affection (probably both I), II, III, IV, Vrt., VI, VII, VIII cranial nerves. April 6th, full restoration to general physical, nervous and mental normal levels; the changes evidenced by left blindness, Babinski, abnormal vestibular reactions and altered reflexes, left abducens weakness and altered pupillary reactions are to be regarded as evidences of a closed pathologic incident, not suggestive of further extensions.

1154 ROOSEVELT BLDG.

XXXIV.

A MODIFIED ATTIC DRAINAGE IN CHRONIC SUP-
PURATIVE OTITIS MEDIA: PRELIMINARY
REPORT.*

JAMES A. BABBITT, M. D.,†

PHILADELPHIA.

Chronic discharge of the middle ear still presents an unsolved problem and this despite the assiduous efforts of most competent otolaryngologists—this term is used advisedly, because the middle ear by definition includes the eustachian tube and mastoid process, and suppurative otitis media is as much a nasopharyngeal as an otologic problem. A review of the field should include all forms of radical and modified radical mastoid operation—attic surgery, from the simple ossiculectomy to Tobey's ingenious attic-mastoid operation through the auricular canal; the high frequency current, infra red light and radium emanation; varied antiseptic and chemical applications, including the iodine powder recently discussed by Lederman. Wagers has included ionization in his reported groups under treatment.

The pathology of this condition is important from focal, auditory and meningeal standpoints—yet somehow it presents two sides: the principle of letting well enough alone, and the constant menace of potential danger. This worries the conscientious specialist who, aided by allergist and radiologist, has been enabled to practically clear his field with two major exceptions, progressive deafness and this chronic middle ear infection. Advocates of the surgical and antiseptic procedures may contest this statement, for they have had a considerable measure of success, perhaps even greater than published. The field is, however, still one of research, and the problem of the sclerotic mastoid is linked to

*Presented before the Section of Otolaryngology, College of Physicians, Philadelphia, April 15, 1931.

†From the Department of Otolaryngology, Hospital of the University of Pennsylvania.

it, the analysis of the life history and status of which engages widespread investigation.

At the last meeting of the American Otological Society a symposium on this subject was presented by Shambaugh, Tobey and Morrisset Smith. The writer in discussion suggested a midway course between conservative and surgical procedure. This method was to establish by blunt probes and curet a free drainage directly upward from tympanic perforation, through the posterior superior quadrant to the antral opening. The results in ten cases were reported, with success and dry ears in all but one.

This, in brief, is the theme of this informal contribution, presented as a preliminary report only, without claim or apology. Experience will prove its value or discard it. It presents the immediate results in twenty-three cases, some bilateral; in all, twenty-nine ears operated upon during the past three years. The group is small, the study of etiology and associated pathology has been meager; X-ray studies graciously offered by one of our best technicians have scarcely begun; postmortem studies would only be valuable upon a case previously operated upon, and this fortunately has not been possible. The only warrant for presentation lies in the fact that a majority present cured "dry" ears at this time, that all the cases were improved, that hearing level has apparently been raised, and the complication list includes but one case—a rotary nystagmus and vertigo of but three days' duration, which might belong to the rather severe mastoid exenteration on the opposite side performed at the same time by an associate.

In chronic disease of the middle ear, the attic space becomes badly damaged. It is conceded that at least the antrum of the mastoid shares the involvement. The squamous cell areas, promontory, ossicles and tympanic membrane, afford special opportunity for fibrous change. The whole area may be semi-obliterated by thickening, sclerosis and adhesions, so that the drainage downward from the *iter ad antrum* remains but a narrow, tortuous channel, defying simple treatment. It seemed possible, if this upper posterior quadrant could be converted into an open,



Demonstration on cadaver of modified attic drainage. The tegmen tympani is lifted and probe is seen at entrance of *iter ad antrum*.

rather rectangular drainage, even at further sacrifice of tympanic membrane, but preservation of the annulus, that the trouble might spontaneously cease, that even diseased ossicles, freed from surrounding pressure, might regenerate or cover in their surface sufficiently to become innocuous, and even after this somewhat traumatic disturbance carry audition value. A few experimental cases were haltingly tried—then one rather special result happened which might be reported to the advantage of the procedure.

This patient, R. V., was operated upon early in January, 1930, at the University Hospital, for obstructive symptomatology in the nose—an ordinary submucous resection. There had been a suspicion of sinusitis, but X-ray and nasopharyngoscopic studies were negative. About a week later complications occurred—tubal extension with a double suppurative otitis media and suspicion of mastoiditis. The patient escaped operation, but the purulent ear discharge persisted with low, irregular temperature. On one side this continued for two months after onset with no response to treatment.

The patient was admitted to the Lankenau Hospital and this simple attic operation was performed. Within five or six days discharge had stopped, the perforation area soon filled in with almost normal membrane appearance, has remained dry and the hearing level has been substantially raised.

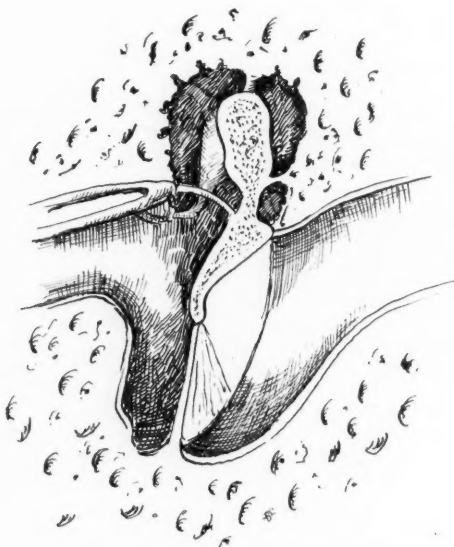
In all of these reported cases a reasonably painstaking effort was made with palliative measures. The earlier ones occurred before such a general use of the iodine powder pertained. In some of the later cases this was adjuvant to other treatment.

DISCUSSION OF CASE LIST.

The first three cases represented a somewhat partial procedure. In one of them an independent lower drainage proved successful. In the eight following cases one remained dry most of the time but had four relapse periods of several days and is not yet stable; one had a brief relapse during an influenza period; another continued an aggravating tinnitus, slightly present before operation, but this is gradually subsiding.

Three presented much attic pathology, polypoid granulations and cholesteatoma with long continued, somewhat intermittent, foul discharge; one had an atypical neuralgia which ceased after operation; in one, with a ten year history of bilateral discharge, the left ear healed immediately and remained dry—but the right required treatment of granulations for several months.

The third group of six cases was a recent Children's Hospital group. Half of them promptly remained dry—one was much



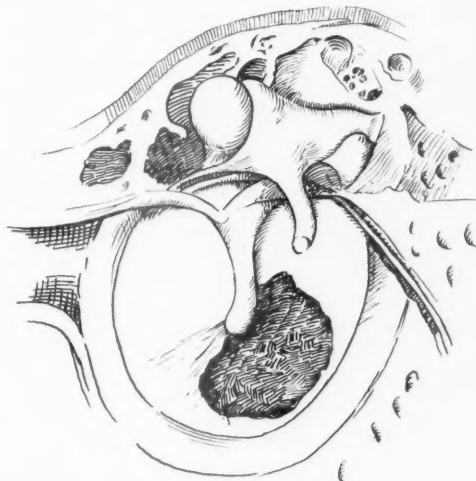
Lateral view to demonstrate attic area.

improved but still has periods of scant mucoid discharge; a fifth was unsuccessful and though improved must be reoperated; the sixth is still convalescent but promising.

The fourth group of four cases—a recent University Hospital list—includes five actual ears. Two are dry, three practically so, and one has an obstinate spot of granulation area with discharge—but mother reports a complete improvement in physical and mental morale. The last two cases are still convalescent, one a

man, seventy-four years of age, operated upon in hope of averting mastoidectomy, with favorable result, and the other operated upon five days ago, had a small, high, anterior perforation. Where not completely cured, the cases have shown such marked improvement in local pathology that the results are encouraging. At least eighteen of the twenty-six completed ears represent success to present date.

Age range is from four to seventy-four years, duration of discharge from six weeks to fifteen years, though the time period



Posterior view of perforated membrane, showing attic area.

seemed, rather strangely, to bear little relation to success or speed in recovery. This is, of course, too small a group for conclusions—hundreds of cases would be necessary for any ratios of value, but this is only a preliminary report.

SELECTION OF CASES.

Three preliminary conditions are important:

First.—The mastoid, except for its antrum, should be in a quiescent state. The so-called sclerotic or eburnized mastoid,

whatever its interpretation, should present the best prospect. Case R. H., a boy, four years of age, was diagnosed by X-ray as in a state of mastoid infection. The mastoid of the more unfavorable ear was operated first, found to be in eburnized state with hard bone, no open cells, but a slightly softened area near the tip. The structure was so osseous that the antrum was almost manufactured by curet. Therefore, the attic operation was done on the opposite side with complete recovery in four or five days. Ear is now dry.

Second.—Contributing factors should be eliminated first, not only to allow a possible escape from surgery, but, of far more importance, to eliminate a probable factor in recurrence of trouble. This refers to such conditions as adenoids, infection in posterior ethmoids and active infections in the auricular canal or glands about the ear.

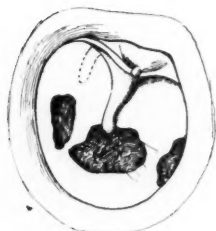
Third.—Only improvement should be forecast to patient, as a second or third procedure might be necessary. The prospect of improvement may, however, be safely given, as the operation is simple, requires but a brief period under nitrous oxid and oxygen, has little pain in sequence, and repetition in finally controlling drainage should not be contraindicated. The indications so far have pointed to improvement in hearing, even in repetition. The fallacy in this, of course, lies in the fact that preliminary hearing tests must be made on somewhat moist ears. The point to be made is simply that hearing has apparently not been damaged.

Procedure.—As indicated by the slides, the procedure is to work from the posterior inferior quadrant. If perforation is anterior, lateral or inaccessibly high, make a fresh incision and continue up under portion of tense and full depth of flaccid membrane in posterior superior quadrant, reaming this space out with blunt right angled probe. After cleaning this space thoroughly, bite off sufficient portions of overhanging membrane to secure free drainage. Push aside, if necessary, but avoid removal of any portions of malleus or incus. If the former protrudes loose in the lower enlarged opening, later healing will render it stationary and perhaps still somewhat effective in sound transmission. The final step is to insert angular curet reaching to the

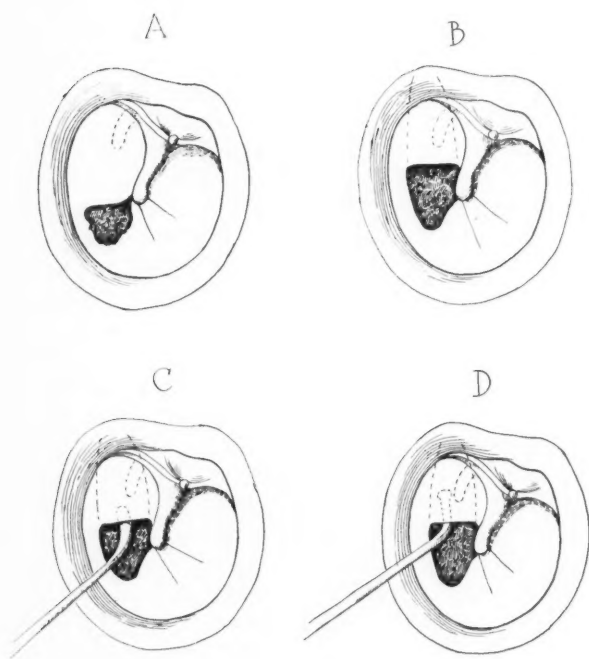
neighborhood of the *iter ad antrum* and curet away any blocking granulations. It would seem possible for this to disturb the facial nerve, as it passes down beneath the passage from attic to antrum, but this accident has not so far occurred, nor has any nerve irritation been noted. The field is kept clear during operation by suction and bleeding is easily controlled. A further procedure might be the attempt to burr out and close the eustachian tube mouth through the opening. That has not been attempted and would technically mar the simplicity and ease of this simple operation, which has so far met with much success without it.

With the courteous co-operation of Dr. Batson, of the Graduate School Department of Anatomy, the result of this operation was tested upon the cadaver, with the tegmen tympani removed. The course of the instrument lateral to the head of the incus, posterior to head of malleus and anterolateral to stapes, was demonstrated. An angular probe readily and safely reached the entrance of the *iter ad antrum*. The instruments used have simply been an assembled group from those already devised for various types of attic work through the auricular canal. It might be advantageous to have a longer right angled probe (Fig. D) and somewhat modified curve in the oblique curet (Fig. G).

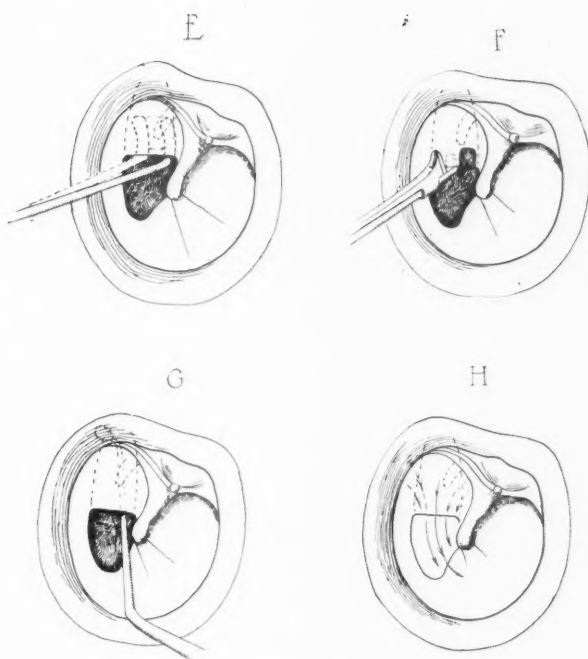
After-Treatment.—This has been more or less empirical. The patient has been kept in bed about three days. At the time of operation a strip of gauze packing is inserted, dipped in mercurochrome or metaphen solution. This is allowed to remain over the first night and a regular mastoid protective dressing is applied. The following day the ear is irrigated by bulb syringe with warm normal saline, the canal dried by cone of cotton held in forceps and a few drops of 2 per cent phenol in glycerin instilled into the canal. This is irrigated at first every three hours, after first thirty-six hours reduced to three times daily. In four or five days the discharge lessens, active irrigation is stopped, the ear is wiped with a cotton swab and touched with strong metaphen solution. All this has seemed possible with the removal of little or no actual bony structure. The reconstruction in the tympanic area may occur within a very few days, and conditions are usually quiet within two or three weeks.



Types of perforation appropriate to this procedure.



Operative steps in modified attic drainage.



Operative steps in modified attic drainage—continued.

It is quite possible that all this irrigation is superfluous, but conditions are not similar to early acute catarrhal or acute suppurative involvement of this area. There has been a fairly definite mixed infection present for a long period, and the antrum and mastoid have picked up quite as much infection before operation as they are likely to afterward. The single important point in the immediately convalescent period is to maintain a sure drainage.

Questions have arisen in recent discussion as to the similarity of this procedure to the time honored attic curetage, as to the lateral displacement of the malleus and incus, and the possible injury to the chorda tympani nerve.

This is indeed a modification of general attic curetage, but seems to be producing better results. In skilful hands the attic curet alone might obtain this drainage passage, but it would seem difficult to ream out such a direct channel and reach so adequately the *iter ad antrum*.

Doubtless the larger ossicles are moved anterolaterally by release of ligamenture and tympanic folds, but if the ossicular joints are not detached they should remain somewhat serviceable.

There is doubt as to the amount of actual harm occurring from irritation of the chorda tympani in an attic already so pathologic, but further research should determine this.

CONCLUSIONS.

The results would seem to justify this procedure as a preliminary measure when palliative treatment fails.

The accidents most likely to happen would be disturbance of the incudostapedial articulation or the stapes plate in the oval window, injury to the facial nerve, opening a passage to the meninges in a very necrotic wall. Such accidents are not likely to occur if manipulation of instruments is gentle—the procedure is a simple attic drainage and should be performed as such.

The reconstruction in the middle ear, as so far observed, has augmented rather than diminished hearing, has not increased tendency to tinnitus, and in some cases has quite repaired the pre-existing damage in the tympanic membrane. Where discharge has continued, it is quite mucoid in character, without odor, and

drainage seems adequate. The tendency to scar tissue and fibrosis in regenerated areas may be balanced against the satisfaction in controlling active sepsis.

The case list presents twenty-six completed ears and three still convalescent. At the time of this paper, eighteen (69.2 per cent) are dry. Of the remainder, four show 80 per cent improvement, and four are still doubtful. The high percentage may not continue, and discharge may recur in some cases, but it would seem reasonable to expect 50 per cent of success, and no cases thus far show ill effects from operation.

1912 SPRUCE STREET.

A MODIFIED ATTIC DRAINAGE (PRELIMINARY REPORT)

Case	Age	Ear	Dur. Disch.	Date Oper.	Result
J. B.	25	Both	5 yrs.*	Feb., 1929	L. Dry, R. 90% **
E. R.	38	Left	10 mos.	March, 1929	Dry
E. C.	20	Right	15 yrs.*	March, 1929	Dry
P. R.	35	Left	3 yrs.	June, 1928	60% **
C. M.	40	Right	8 wks.	March, 1929	Dry
A. A.	45	Left	6 yrs.	1929	Dry
M. W.	26	Both	5 yrs.*	Nov., 1929	Dry
R. V.	41	Right	3 mos.	March, 1930	Dry
M. R.	27	Left	12 mos.*	May, 1930	90%
S. M.	16	Both	10 yrs.*	Aug., 1930	Dry
D. S.	18	Left	4 yrs.	Aug., 1930	Dry
J. S.	11	Both	5 yrs.	Oct., 1930	30% **
H. P.	8	Both	8 yrs.	Nov., 1930	80% **
T. G.	11	Right	3 yrs.	Nov., 1930	Dry
E. L.	3	Right	10 days	Jan., 1931	Dry
M. A.	5	Left	7 wks.	Jan., 1931	Dry
S. B.	6	Left	2 wks.	April, 1931	Pending
M. C.	14	Right	2 yrs.	Jan., 1931	50% **
R. H.	4	Left	2 yrs.	Feb., 1931	Dry
E. B.	15	Right	4½ yrs.	Feb., 1931	Dry
V. G.	29	Both	10 yrs.	March, 1931	Dry
F. R.	74	Left	6 wks.	March, 1931	Pending
L. K.	(55)	Left	2½ yrs.	April, 1931	Pending

* Intermittent. ** Percentage Improvement.

Total, 23 cases—29 ears—3 ears still convalescent.
18 (69.2%) dry. Of the balance one-half show 80% or more improvement.
One-half still doubtful.

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XXXV.

THE STATUS OF THYROTOMY FOR CARCINOMA
OF THE LARYNX.*

GORDON B. NEW, M. D.,†

ROCHESTER, MINN.

INTRODUCTION.

A review of the literature reveals that there is much diversity of opinion as to the end results of thyrotomy for carcinoma of the larynx. Some reports show particularly good results, whereas others show a discouragingly high percentage of recurrences.

In England laryngofissure is more commonly employed than laryngectomy, possibly because of the general belief that chronic hoarseness is often the first sign of carcinoma, and induces patients to present themselves at an earlier stage of the disease; hence the development of an operation by means of laryngofissure which is really hemilaryngectomy.

As a rule, patients with carcinoma of the larynx have but one chance of getting well if operated on. The results from laryngectomy for recurring carcinoma following thyrotomy are not good. In this country most laryngologists prefer laryngectomy if the carcinoma is of questionable extent, so that laryngectomy is done two to three times as often as thyrotomy.

A review of the end results in forty-one cases at The Mayo Clinic in which thyrotomy has been done for carcinoma of the larynx in the last six years, would seem to indicate that this type of operation has a definite place in the treatment of carcinoma of the larynx in a selected group of cases.

SELECTION OF PATIENTS.

In this country most laryngologists feel that epitheliomas limited to the anterior two-thirds of the vocal cord without fixation

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†From the Section on Laryngology, Oral and Plastic Surgery, The Mayo Clinic.

are the type best suited for thyrotomy. Slight lagging of the cord in a low-grade tumor may not contraindicate this type of operation.

The success or failure of any operative procedures, regardless of the situation or size of the growth, depends largely on the degree of malignancy of the epithelioma—that is, its tendency to recur locally or to metastasize. This very important factor usually is not stressed in determining whether thyrotomy, or laryngofissure, should be done. Although a large carcinoma graded 1, may be safely taken care of by means of laryngofissure, an attempt to remove one graded 4 of similar size with a conservative operation would be hopeless as regards a good permanent result. It is generally conceded that carcinomas of the larynx vary greatly in degree of malignancy. Similarly it may be said that members of the cat tribe vary in ferociousness. They are not all kittens nor are they all tigers. Broders' gradation of carcinoma indicates that carcinoma graded 1 is little more than a benign lesion, it does not metastasize, and the prognosis is usually good with reasonable treatment. On the other hand, carcinoma graded 4 is highly malignant and metastasizes early. These different types of carcinoma act differently and they require different treatment. Differentiation of the growth as to its histologic character is sometimes more important as regards treatment and end results than the technic of operation or the particular method of operation employed. I do not mean that there are not many other factors which have been stressed for years in determining the operability of carcinoma, but I do feel that this additional factor should be given more consideration.

In selecting patients for operation, besides the usual carefully taken history and clinical examination, a biopsy is made and a fresh tissue microscopic examination is done just before operation, thus affording additional information as to the type of growth to be dealt with. Although in many cases the appearance of the growth is such that microscopic examination is not necessary to determine its activity, in most cases the examination is of great benefit in determining just what should be done. One exception to the foregoing plan of treatment is illustrated by a

patient who had a very short, fat neck and it was impossible to get a view of the anterior part of the larynx for biopsy. Laryngofissure was done as an exploration, and a squamous-cell epithelioma graded 3 of the anterior fourth of one vocal cord was found and removed. If the lesion is highly malignant and there is any question about whether it is suitable for thyrotomy, laryngectomy should be the treatment of choice. If the growth is of the anterior commissure I believe laryngectomy should be performed. Although the method of Jackson, as described by Tucker, for the treatment of anterior commissure growths might be used for a tumor of low-grade malignancy, if the tumor is of a high grade of malignancy such an operation necessitates getting too close to the growth to insure a good result. In a small group of cases in which it is difficult to determine by all methods whether a conservative operation is advisable, I prefer to do a two stage procedure, the first stage as in a first stage laryngectomy. At the time of the second stage, a thyrotomy is done, and at this time the growth can be removed and destroyed with diathermy or laryngectomy may be performed, as seems indicated.

TYPE OF OPERATION.

All patients in the clinic on whom thyrotomy is to be done receive ethyl (1-methyl-butyl) barbituric acid (embutol) the night before the operation, and about half an hour before operation the following morning. The dosage is from $1\frac{1}{2}$ to 3 grains each time. This gives the patient a comfortable sleep and when he comes to the operating room he has lost all sense of fear. He is also in a condition to cough up the tracheal secretions after the operation. Paravertebral block anesthesia is induced by 0.5 cc. of 1 per cent procain. Local infiltration of the anesthetic agent about the median line of the neck is also employed. A median-line incision is made, the hyoid bone is divided by bone forceps and the ends are retracted with sharp retractors. This allows the larynx to come up into the wound and give good exposure. The anterior part of the thyroid cartilage is freed from muscle down to the cricoid cartilage, exposing the cricothyroid membrane. A few drops of 10 per cent cocain is injected through the cricothyroid membrane. The thyroid cartilage is divided by means of

a saw along with the lower part of the cricothyroid membrane. Sharp, pointed forceps pick up the thyroid cartilage and retract it, which affords good exposure of the inside of the larynx. After careful inspection of the growth it is removed by sharp dissection, wide of the growth. The base of the wound is then destroyed with surgical diathermy, using a small, protected, vulcanite point with the spark gap almost closed so that there will be little penetration of the heat beyond the surface. In this way extensive sloughing or destruction of the cartilage does not occur. It may be necessary to use catgut sutures on a curved needle if any small vessels require tying. The thyroid cartilage is not removed, as if the growth is fixed to the cartilage the patient is better off with laryngectomy. If the thyroid cartilage is to be removed, I believe it should be done in one piece along with the soft tissues and the growth, and not removed secondarily after the growth and the soft tissues. A tracheotomy tube is inserted only when it seems to be necessary because of the resultant reaction and local edema. The thyrohyoid and cricothyroid membranes are closed with catgut sutures, and a split drain is inserted in the lower part of the wound to prevent the possible occurrence of surgical emphysema. If patients are debilitated or are bad surgical risks, due to chronic upper respiratory infection, a two-stage operation is done.⁵ A Rehfuess feeding tube is inserted through the nose into the stomach in cases in which it is felt that the local edema of the larynx will interfere with swallowing for a few days. In this way the swallowing of fluids into the trachea is prevented.

COMPLICATIONS.

In the series of forty-one cases in which thyrotomy was done, there was no operative mortality. Other than for local reactions the patients were only slightly inconvenienced. When it is thought advisable to use a tracheal tube, this is usually removed within a few days to a week, after the local edema subsides. Occasionally delay in healing, due to a small piece of cartilage or bone from the margin of the divided thyroid cartilage, keeps up the drainage. I have never seen any extensive sloughing of the cartilage secondary to the use of diathermy in these cases. This, as I have mentioned, is probably due to keeping the spark

gap almost closed so that there is very little penetration of the coagulation.

RESULTS.

There is little uniformity in end results following thyrotomy. Jackson, in 1922, reported twenty-nine cases in which the patients were well for three years; twenty-three were free of recurrence. Schmiegelow reported twenty-eight cases in ten of which there was recurrence. Lynch reported a very unusual series of twenty-six cases in which suspension and dissection was carried out with only two recurrences. The microscopic grading of these lesions would make an interesting study. Mackenty reported that 35 per cent of his patients on whom thyrotomy had been performed returned with recurrences; he stated that this bitter experience has made him lean toward radicalism in the treatment of all patients with carcinoma. Tucker's report on fifteen cases is too recent to be of any value as to end results. Thomson's recent report, based on seventy cases, revealed that after deducting from them the operative deaths and deaths from other diseases before the end of the three-year period, there were 76 per cent cures.

Colledge reviewed all sixty cases of Thomson's, in which microscopic examinations had been done. Of the sixty cases, fifteen were graded 1 with one recurrence (6.6 per cent); one of the extensive subglottic growths was a carcinoma, graded 1, and the patient had been free of recurrence eleven and a half years. Eighteen were graded 2, and sixteen were graded 3 with seven recurrences (26 per cent). In eleven cases lesions were graded 4 with eight recurrences (72 per cent). In the entire series of sixty cases there was 25 per cent recurrence.

Of the forty-one patients operated on at The Mayo Clinic within the last six years, there are twenty-three who were operated on more than three years ago. Three of these had local recurrence. Cervical metastasis did not occur. Of the twenty-three patients eighteen had epitheliomas graded 2 and five had epitheliomas graded 3. One of the eighteen patients had recurrence, and two of the group of five had recurrence. Two of the twenty-three patients died of other conditions without recurrence of the epithelioma, one following prostatectomy and the other of diabetes. Of the twenty-three patients who had been operated

on more than three years previously there were three (13 per cent) who had local recurrence. One recurrence was a minute area appearing after two years, and was removed at biopsy. When the second thyrotomy was performed the tissue removed did not show carcinoma. The second recurrence was from a growth graded 3, and was too extensive for thyrotomy. The third recurrence was extensive from an epithelioma graded 2. The patient was a physician and at his request a second thyrotomy was done instead of laryngectomy. Of the eighteen patients operated on less than three years ago, eleven were operated on more than two years ago, with two local recurrences. One patient is a woman, aged twenty-four years, on whom thyrotomy was done, although the lesion was very extensive and graded 3. When the lesion recurred laryngectomy was done and the patient has been well more than a year. The second patient was a youth, aged twenty-one years, on whom thyrotomy was done for epithelioma graded 2. The lesion was too extensive for this procedure, and I feel that if laryngectomy had been done the patient would be well at the present time. Of these thirty-four patients who were operated on more than two years ago, four (14.7 per cent) had recurrences.

SUMMARY AND CONCLUSION.

The additional information which may be obtained by biopsy, frozen section and histologic examination just previous to operation, with the history and clinical examination of the patient, should determine the type of operation and the treatment of carcinoma of the larynx.

The end results in carcinoma of the larynx, as illustrated both in Colledge's report of Thomson's patients and our own group would indicate that microscopic grading of carcinoma is of definite value in addition to the clinical examination, not only in determining the type of treatment but also the prognosis.

In a selected group of patients subjected to thyrotomy and surgical diathermy for carcinoma of the larynx there was no operative mortality and only 13 per cent of the patients had recurrence after three to six years.

THE MAYO CLINIC.

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XXXVI.

THE ROENTGEN FINDINGS IN SUPPURATION OF
THE PETROUS APEX.*

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This presentation is based upon the clinical work of Dr. Samuel J. Kopetzky and Dr. Ralph Almour, at the Beth Israel Hospital, New York City. The roentgen findings have been verified at operation, and a detailed report of the clinical entity, operative procedure and cases is appearing serially in the *ANNALS OF OTOLGY, RHINOLOGY AND LARYNGOLOGY*, 1930 and 1931.

At the onset of this work, a request was made to determine the presence of roentgen findings which would be of assistance in arriving at a diagnosis of suppuration of the petrous pyramid exclusive of labyrinthitis. This, in brief, presents the following symptom complex: A suppurative mastoiditis in an extensively pneumatized temporal bone, followed by continued profuse otorrhea after mastoidectomy; pain along the distribution of the first branch of the trigeminal nerve, particularly retro-orbital in character; and a low grade sepsis. This symptom complex has been described by the authors as pathognomonic of a deep seated purulent focus within the petrous pyramid.

The mastoid portion of the temporal bone normally undergoes pneumatization. The amount and character of the pneumatization varies in different individuals, depending upon factors which influence this process early in life (Wittmaak¹). When it is normal the end result is a fully pneumatized mastoid process. In addition, it is not uncommon to find that the process of pneumatization has extended to the squamous, zygomatic and occipital bones. Pneumatic cells have also been described around the mouth of the eustachian tube, the floor of the middle ear and in the teg-

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men tympani. Tracts of cells have also been found which originate in the epitympanic space and inner antral wall and which lead directly into the petrous apex. Siebenmann² has described four tracts of cells coalescing in the petrous apex. Girard³ described a chain of cells extending from the peritubal area into the petrosal tip, and extending as far as the foramen spinosum of the sphenoid. Mangebeira-Albernaz⁴ described a temporal bone whose pyramid showed a large cell measuring $29 \times 14 \times 9$ mm., the whole pyramid measuring 48 mm. in length. Baldenweck⁵ described a petrous bone in which the tip was entirely composed of two large cells. Collet⁶ described a pyramid which contained a large cell in the tip, measuring 10×12 mm., which was surrounded by and communicated with smaller cells. Von Troeltsch⁷ noted the occurrence of pneumatic spaces within the pyramid. Merkel⁸ described the frequent occurrence of pneumatic spaces within the petrous pyramid resulting in a pneumatization of more than one-half of the petrosa. Urbantschitsch⁹ often noted small bony foramina in the vicinity of the tubal ostium and in the upper posterior half of the inner tympanic wall, through which openings a probe could be passed into the pneumatic spaces well forward into the tip of the petrous pyramid. Eagleton¹⁰ has described tracts of cells situated in the perilabyrinth which led from the region of the superior semicircular canal directly into the petrous tip.

Profant¹¹ made anatomic studies of petrous bones in three fetuses, two full term infants and fifty adults and states that "a specimen with a well developed mastoid had a well developed petrous, and one with a sclerotic mastoid had a sclerotic petrous." He also says that "in order to obtain statistics as to the frequency and extent of pneumatization of the petrous bone, several hundred dissections should be made. From the number that I have made I am convinced that cells are frequently present, at least in some portion of the petrous."

Ballance¹² states that "the too exclusive use of the term mastoid cells has possibly, to some extent, obscured the importance of other parts of the complex network of intercommunicating air spaces which surrounded the tympanum. The mucous membrane lining the whole of the complex space is a direct extension of that

of the tympanum. The air cells are in no way prevented by the sutures from extending, more or less widely and in continuity from one bone to the neighboring bone."

Belinoff and Balan¹³ studied the petrous pyramids of 40 temporal bones and found the diploeic type in 22.5 per cent, the pneumatic type in 35 per cent, and the mixed cell type in 42.5 per cent. In 37.5 per cent the structure of the mastoid process and pyramidal apex were identical, and in 62.5 per cent they differed.

They give Zuckerkandl's figures of 250 mastoids examined, as showing the diploeic type in 20 per cent, the pneumatic type in 36.8 per cent, and the mixed cell type in 43.2 per cent. While the former examined petrous portions of the temporal bones and the latter the mastoid portions, the percentages are almost alike. These figures are significant, for according to Belinoff and Balan, the structure of the mastoids and pyramids are identical in 37.5 per cent of specimens examined.

It is thus seen that in well pneumatized temporal bones pneumatic spaces may be present in the perilabyrinthine area and in the petrous tip as well as in the mastoid process. Therefore, with such a large percentage of cases showing pneumatized petrous pyramids, the same interpretation can be attributed to the roentgenology of the petrous tip as we use in interpreting the radiographic findings in pneumatized mastoid processes.

TECHNIC.

In radiography of the petrous portion of the temporal bone it is advisable to take both sides with one exposure. After trying innumerable positions I have found that the most useful information is obtained from a base plate. Other positions, viz., the anteroposterior and postero-anterior oblique projections, give better general outlines to the pyramid, particularly the apical portion, but do not supply as much useful information as the base plate. The Mayer position gives better detail as to the structure of the petrous base, but does not show as clearly the changes required for a diagnosis of petrous pyramid suppuration or apical destruction. The same holds true for other positions attempted.

Various attempts have been made to visualize clearly the petrous pyramid roentgenologically. The inferosuperior projection (base plate) has been described and utilized by Hirtz¹⁴, Schüller¹⁵, Hasselwander,¹⁶ Grashey,¹⁷ Baldenweck and de Prades,¹⁸ and Worms and Breton.¹⁹ A supero-inferior projection, which is somewhat similar to the base plate, has been described by Hirtz,¹⁴ Grashey,¹⁷ Altschul²⁰, and Worms and Breton.¹⁹ A postero-anterior projection, which throws the pyramids into the orbits or in the region of the orbits has been described by Schüller, Hasselwander¹⁶ and Grashey.¹⁷ The above projections show both pyramids.

Oblique and eccentric projections, visualizing only one pyramid with each exposure, have been described by numerous authors. The postero-anterior oblique has been described by Stenvers,²¹ Bigler,²² Hasselwander,¹⁶ Lannois and Arcelin,²³ Schüller and Hirsch.²⁴ Similar appearances are obtained by the antero-posterior oblique, as described by Staunig and Gatscher.²⁵ Modifications of the oblique positions, with the head in the lateral position, giving appearances similar to the obliques, have been described by Löw-Beer²⁶ and Fischer and Sgalitzer.²⁷ Mayer²⁸ described a position for the petrous bone which is an anteroposterior oblique entirely different from the others.

The advantage of the base plate over the other positions is that it shows the surrounding bony structure for contrast, and the opposite pyramid for comparison on a single plate.

The routine mastoid examination in our hospital at the present time includes a stereoscopic examination of the mastoid processes, a base plate and an anteroposterior oblique projection of each petrous pyramid. The base plate and the anteroposterior oblique projections of the pyramids are reference plates to be used for comparison, should a case subsequently develop symptoms suggestive of petrous pyramid suppuration. In such an instance these earlier pictures can be compared with those taken at a later date and so enable us to determine the earliest changes from the normal.

The anteroposterior oblique projections are used solely to determine if we cannot locate a change in density or localize an

area of destruction along the superior surface of the petrous pyramid. Since the postero-anterior oblique projection of the petrous pyramid is practically identical with the anteroposterior oblique projection, I have adopted the latter, because it is more comfortable for the patient to be rayed in the supine position.

To obtain radiographs of good quality it is essential to use a fine focus tube with a small or medium sized cone. The head should be immobilized after being placed in the proper position. I employ intensifying screens; the Potter-Bucky diaphragm may be used, although the best results are obtained without it.

The position for the base plate that I employ is as follows: the patient is supine; the head is lower than the rest of the body and rests on the vertex, so that a line drawn through the auditory meatus and superior orbital margin is parallel to the table. The sagittal plane of the head is perpendicular to the table. The plate is horizontal. The tube is tilted upward 15 to 20 degrees, so that the central ray is in the midline, one inch in front of the auditory meatus.

For the anteroposterior oblique projection of the pyramid, the patient is supine, and the head is rotated 45 degrees to the side opposite the one to be radiographed. In other words, the head is turned to the left when radiographing the right side, and vice versa. The chin is pulled in. The film is horizontal. The central ray is perpendicular to the film and passes through a point one inch above the external angle of the uppermost orbit (right orbit when raying right side, and vice versa). Fig. 3.

For the postero-anterior oblique projection of the petrous pyramid, the patient is prone, the head is obliqued so that it rests on the orbit, malar bone and nose of the side to be radiographed. With the head in this position, an imaginary perpendicular plane drawn through the auditory meati should be at right angles to the long axis of the film. The film is horizontal. The central ray is perpendicular to the film and passes through the apical portion of the petrous pyramid. To obtain this, the central ray is directed about one-half cm. above the external auditory meatus in a plane passing through the outer border of the orbit. The ray is directed through the opposite occipital area. Fig. 2a.

INTERPRETATION.

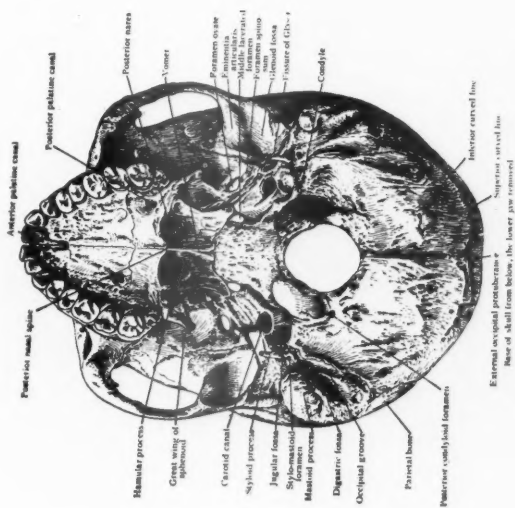
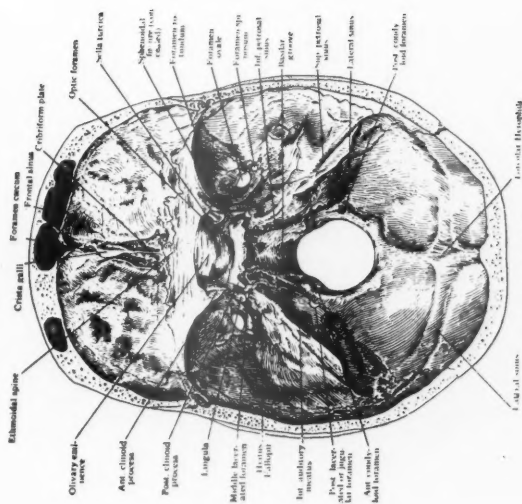
As previously mentioned, the information obtained from a base plate is more useful than that obtained from the other positions. The extent of the pneumatization in the petrosa can be determined and the entire pyramid outlined.

It is an established fact that a roentgenogram of a pneumatized mastoid process in a case of acute purulent otitis media shows a slight diminution in aeration. An analogous finding in raying the petrosa is a slight diminution in aeration of the petrous portion when pneumatized in an acute purulent otitis media or acute mastoiditis. By the change in aeration of the petrous pyramid the diseased ear can be determined, without knowing the history of the case or seeing the radiographs of the mastoid processes. This diminution in aeration of the petrous portion is due to a congestion of the membrane lining the air spaces.

One of the earliest findings in petrous pyramid suppuration is a marked diminution in aeration with loss of trabeculations. This change is followed by a decalcification or atrophy of the apical portion, the contour of the apex remaining intact. This decalcification extends from the apex laterally for one-half inch or more and ends rather abruptly medially to the labyrinth. This change in density may become so intense that the apical portion of the pyramid appears only as a very faint shadow. The basal portion shows a relative or real increase in density. With progression of the lesion there is perforation and destruction of the contour of the apex.

In the presence of clinical symptoms pointing to petrous pyramid suppuration, these findings are very significant and indicate operative interference. If there are roentgen changes in the petrosa, and there are no associated clinical symptoms pointing to petrous suppuration, a positive diagnosis from the roentgen findings alone should not be made. With more experience I may change this view, but at the present time I deem it best to be conservative.

If the petrous tip is not pneumatized, the above changes do not ensue. This is of importance to the clinician, for in a diploeic type the frank suppuration does not take place (Kopetzky and



Almour.^{29 30}) Such a type may give an osteomyelitis of the petrous tip (Eagleton³¹). With the anteroposterior oblique projection of the petrous pyramid changes of an osteomyelitis may be detected. I am unable to say this definitely, for I have had no such cases.

RADIOGRAPHIC ANATOMY.

The base plate is an inferosuperior projection of the skull and shows the structures located on the basis cranii.

Since this paper is confined to the radiography of the petrous pyramid, I will describe only those structures which are essential for orientation.

This projection shows the structure of the pyramid and the superior and inferior surfaces. Compare Fig. 1 b and 1 c 1.

The medial portion of the posterior surface is also included, up to the internal auditory meatus. (Fig. 1 b and Fig. 1 c 2.) The opening for the carotid canal on the inferior surface is easily identified, and the canal occupies the anterior part of the apical portion (Fig. 1 a and Fig. 1 c 3). The auditory meati are usually not visualized (although the internal auditory meatus may sometimes be seen). The middle lacerated foramen is situated at and internal to the apex (Fig. 1 a and Fig. 1 c 4). The apex is limited internally by the basilar process of the occipital bone (Fig. 1 a and Fig. 1 c 5), and in the groove formed by the two bones is the inferior petrosal sinus (Fig. 1 b and 1 c 6). Posteriorly and medially is the posterior lacerated or jugular foramen (Fig. 1 b and 1 c 7). The jugular fossa on the inferior surface of the petrous portion cannot be visualized. The posterior limit of the petrous is the boundary between the middle and posterior cranial fossæ, to which is attached the tentorium. The superior petrosal sinus runs along the border in a shallow groove, within the attached tentorium (Fig. 1 b and 1 c 8). Lateral and posterior to the petrosa are the mastoid processes, showing the pneumatic structure when well developed (Fig. 1 a and 1 c 9). In the lateral portion of the pyramid is the labyrinth, but its detailed structure cannot be visualized. Anterior and lateral to the apical portion are the foramina ovale and spinosum in the sphenoid (Fig. 1 b and Fig. 1 c 10 and 11). This view also gives useful information pertaining to the ethmoid and sphenoid sinuses.

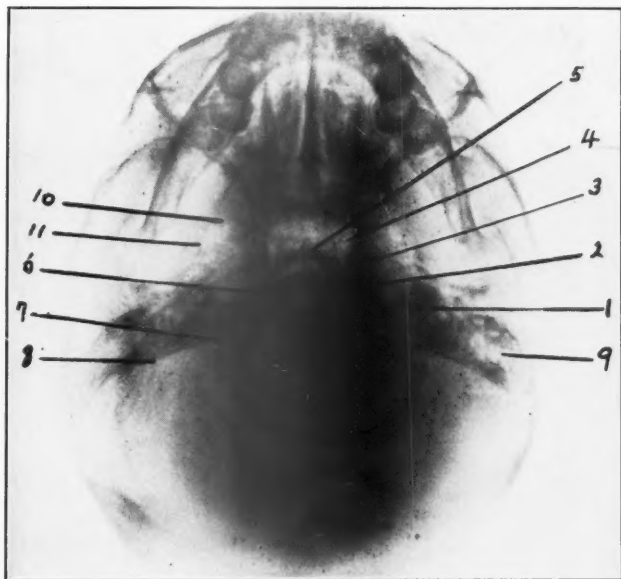


Fig. 1c. 1, pyramid; 2, medial portion of posterior surface; 3, carotid canal; 4, middle lacerated foramen; 5, basilar process of occipital bone; 6, inferior petrosal sinus; 7, posterior lacerated or jugular foramen; 8, superior petrosal sinus; 9, mastoid process; 10, foramen ovale; 11, foramen spinosum.

The anteroposterior and posteroanterior oblique projections give practically identical findings. The schematic drawing Fig. 2 b is a postero-anterior oblique projection and shows the structure within the petrosa and on the anterior and posterior surfaces. The lateral portion also includes part of the superior surface. The type of bony development is not as easily seen in this view. This view outlines the pyramid, shows the apex and also the mastoid process. The internal auditory meatus on the posterior surface is seen. The schematic drawing identifies the structures in the petrous portion and also gives the neighboring anatomic locations.



Fig. 2a. Postero-anterior projection of petrous pyramid, left side. Consult schematic drawing 2b for orientation.

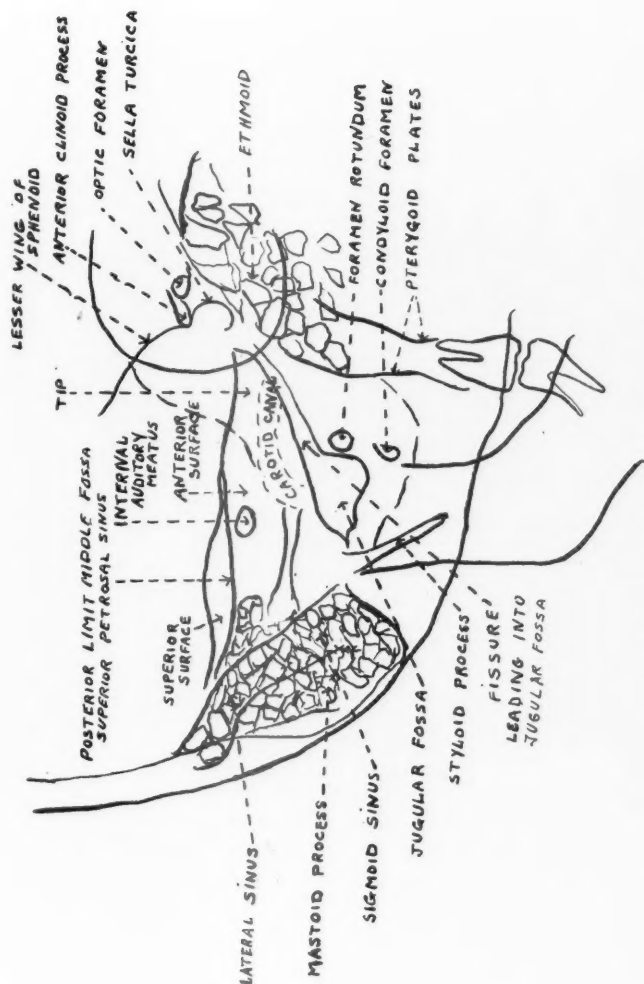


Fig. 2b. Schematic drawing of Fig. 2a.

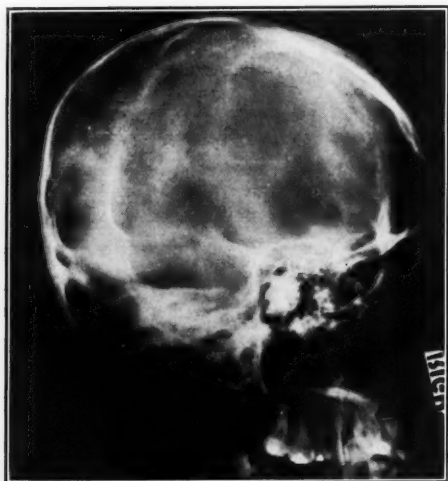


Fig. 3. Antero-posterior projection of petrous pyramid, right side. Note similarity to Fig. 2a.

Case 1.—Male, age 8, was admitted to the Beth Israel Hospital, service of Dr. S. J. Kopetzky, April 10, 1930, with a diagnosis of right petrosal pyramid suppuration.

Chief complaint: Retro-orbital pain, intermittent temperature, discharge from right ear, pain over right frontal bone and right ear.

Radiographic examination, April 10, 1930, showed the petrosæ to be pneumatized. The left petrous bone was normally aerated. The right petrous bone showed a diminution in aeration, with atrophy of the apical portion (Fig. 4). No trabeculations were present in apical portion. The apical contour was intact.

Diagnosis: Petrous pyramid suppuration, right side.

Operation, April 12, 1930, right radical mastoidectomy and drainage of petrous tip. An area of necrosis was found superior to the horizontal semicircular canal, which extended inward and forward above the superior semicircular canal and was removed. The petrous pyramid was entered with a drill and a large cavity



Fig. 4. Case 1. Left petrous bone shows normal aeration. The pneumatization is clearly seen and the trabeculae between air spaces are intact. The apical outline is distinctly visualized. On the right side the apical contour is indistinct but intact and the entire pyramid shows diminished aeration. No trabeculations present.

containing granulations and debris was exposed, from which pus escaped.

Case 2.—Female, age 11, was admitted to the Beth Israel Hospital, April 28, 1930, service of Dr. S. J. Kopetzky, with a diagnosis of right petrosal pyramid suppuration.

Chief complaint: Pain in right eye, dizziness, discharging right ear and temperature.

Radiographic examination, April 28, 1930, showed the petrosæ to be pneumatized. The left petrous bone was normally aerated and intact. The right petrous bone showed a diminution in aeration, loss of trabeculations in apical portion, with some osteoporosis of the tip (Fig. 5). The apical contour was intact.

Diagnosis: Right petrous pyramid suppuration.

Operation, April 28, 1930, right radical mastoidectomy and drainage of the petrous tip. Extensive pneumatization found, extending into the root of the zygoma, beyond the anterior canal



Fig. 5. Case 2. The left petrous bone shows extensive pneumatization and is normally aerated. The left mastoid process is intact. On the right side the operative defect in the mastoid process is seen. From here extending forward and inward the pyramid shows a diminution in aeration with a loss of trabeculations in the apical portion. The apex shows atrophy but no loss in contour.



Fig. 6. Case 3. The right petrous bone shows pneumatization to the tip and is normally aerated. The trabeculations are clearly defined. On the left side the pneumatic structure is seen to occupy the basal portion of the pyramid and shows a diminution in aeration as compared to the opposite side. The medial or apical portion of the pyramid shows intense atrophy due to decalcification and complete loss of trabeculations. The contour of the apex is intact.



Fig. 7a. Case 4. The right petrous pyramid is normally aerated. On the left side there is a slight diminution in aeration but no loss of trabeculations. There is some reactive inflammation at the base of the left pyramid.

wall, down to the tympanic cavity. Tympanic cavity filled with granulations. An area of necrosis was found superior and anterior to the horizontal semicircular canal, which extended inward for one-eighth of an inch, and forward above the horizontal semicircular canal and around it, for a depth of one-half inch. The petrous tip was entered with a drill, pus evacuated with débris and granulations.

Case 3.—Female, age 13, was admitted to the Beth Israel Hospital, service of Dr. S. J. Kopetzky, May 24, 1930, with a diagnosis of left petrositis and meningitis.

Chief complaint: Retro-orbital pain, left side; pain in left ear, discharge, fever.

Radiographic examination, May 24, 1930, showed the petrosæ to be pneumatized. The right petrous bone was normally aerated and intact. The left petrous bone showed a generalized diminution in aeration, with decalcification and loss of trabeculations in

apex (Fig. 6). The contour of the apical portion of the left pyramid was intact.

Diagnosis: Right petrous bone, normal. Left petrous bone, suppuration, apical portion.

Operation, May 24, 1930, left radical mastoidectomy and drainage of petrous tip. Petrous pyramid entered with a drill and a cavity found from which pus was evacuated under pressure.

Case 4.—Female, age 4, was admitted to the Beth Israel Hospital, service of Dr. S. J. Kopetzky, May 20th, 1930, for observation. She had had a bilateral simple mastoidectomy four weeks prior to admission and now complained of pain in left ear.

Radiographic examination, May 21, 1930, showed the petrous pyramids to be pneumatized. The right pyramid was normally aerated. The left pyramid showed a slight diminution in aeration, with no loss of trabeculations. There was some reactive inflammation at the base of the left pyramid. The apical contours were intact (Fig. 7 a).

Diagnosis: No evidences of petrous pyramid suppuration.

She was discharged from the hospital but was readmitted on June 9, 1930, with a diagnosis of left petrositis and meningitis.

Chief complaint: Pain in left ear, discharge from ear, generalized headache, more marked in frontal region.

Radiographic examination, June 9, 1930, showed a marked diminution in aeration of the left pyramid with loss of trabeculations in the apical portion. The apical contour was intact (Fig. 7, b).

Diagnosis: Left petrous pyramid suppuration.

Operation, June 9, 1930, left radical mastoidectomy and drainage of petrous tip. In the region of the inner wall of the tympanic space and antrum necrotic white friable tissue was removed. Middle ear was curetted and eustachian tube exposed. A probe was inserted into the eustachian tube, which passed through a fistulous tract extending forward, inward and upward, towards and into the petrous tip. Immediately there followed a gush of thick white pus which came out under pressure. The opening was enlarged with a burr. A large cavity was found and curetted.



Fig. 7b. Case 4. The right petrous pyramid shows the same appearance as seen in Fig. 7a, taken nineteen days prior to this film. On the left side, however, on comparing with the earlier plate, there are noted a marked diminution in aeration and a distinct loss of the trabeculations in the apical portion. On close inspection, there is a loss in contour of the apex, which was not observed at the original examination.

Radiographic examination, postmortem, with lipiodol injected into the fistulous tract, showed the contrast substance to have extravasated into the subdural space and extended posteriorly above the tentorium (Figs. 7 c and d). The perforation of the apex was not observed at the original examination. Close inspection of the original film showed a loss in contour of the petrous apex. Fig. 7 b.

Case 5.—Female, age $7\frac{1}{2}$, was admitted to the Beth Israel Hospital, service of Dr. S. J. Kopetzky, July 24, 1930, with a diagnosis of petrositis, right side.

Chief complaint: Supra-orbital pain, right side, temperature.

Radiographic examination, July 24, 1930, showed the pyramids to be pneumatized. The left pyramid was normally aerated. The



Fig. 7c.



Fig. 7d.

Fig. 7c and 7d. Radiographic examination, postmortem, with lipiodol injected into the fistulous tract. The contrast substance has extravasated into the subdural space and extended posteriorly above the tentorium.



Fig. 8. Case 5. The left pyramid is normally aerated and shows the trabeculations extending to the tip. On the right side there is a localized osteoporosis of the apex with a loss of trabeculations. The apical contour is intact.

right pyramid showed a localized osteoporosis of the apical portion. There were no trabeculations in the apical portion. The contour of the apex was intact (Fig. 8).

Diagnosis: Right petrous pyramid suppuration.

Operation, July 24, 1930, right radical mastoidectomy and drainage of petrous tip. Petrous tip opened with a drill, opening enlarged and cavity uncovered, which contained pus and thick, soft granulation tissue.

Case 6.—Female, age 4, was admitted to the Beth Israel Hospital, service of Dr. S. J. Kopetzky, August 7, 1930, with a diagnosis of petrositis, right side.

Chief complaint: Pain and discharge from right ear; temporal supra- and retro-orbital pain, right side.

Radiographic examination, August 8, 1930, showed pneumatization of the petrosæ. The apical portion of the right pyramid was atrophic, and showed decalcification of trabeculæ, which were

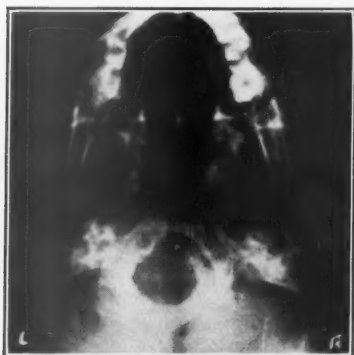


Fig. 9. Case 6. The left pyramid is normally aerated and shows trabeculations. On the right side there is atrophy of the apex and decalcification of the trabeculae, which can still be visualized. The contour of the apex appears slightly irregular.

not destroyed. The apical contour appeared slightly irregular (Fig. 9).

Diagnosis: Right petrous pyramid suppuration.

Operation, August 8, 1930, right radical mastoidectomy and drainage of petrous tip. Petrous bone drilled, large cavity found in tip from which exuded about 1 dram of thick green pus.

Case 7.—Male, age $9\frac{1}{2}$, was admitted to the Beth Israel Hospital, service of Dr. S. J. Kopetzky, November 18, 1930, with a diagnosis of petrositis, left side.

Chief complaint: Draining sinus behind left ear, low grade temperature, frontal headache.

Radiographic examination, November 18, 1930, showed the petrous pyramids to be pneumatized. The pneumatization was most extensive on the lateral portion. The inner and tip areas were not markedly pneumatized. The right petrous bone was normally aerated. The left pyramid showed a marked diminution in aeration, loss of trabeculations, atrophy and partial destruction of the apex (Fig. 10 a).

Diagnosis: Left petrous pyramid suppuration, with partial destruction of tip.



Fig. 10a. Case 7. The right petrous pyramid is pneumatized and shows normal aeration. The pneumatization is more extensive on the lateral portion, while the tip and inner portion are not markedly pneumatized. On the left side there is a distinct loss of trabeculations, a marked diminution in aeration, atrophy and partial destruction of the apex.

Operation, November 19, 1930, left radical mastoidectomy and drainage of petrous tip. A large fistulous opening was found above the horizontal semicircular canal and posterior to the superior semicircular canal. A probe was inserted for one and one-half inches into this opening in the direction of the petrous apex. This cavity was filled with granulations, and bone could be felt all around. The opening was enlarged with a drill and drained.

Radiographic examination, November 20, 1930, with probe in situ, showed the tip of the probe in a large space communicating with the petrous tip (Fig. 10b).

Radiographic examination, same day, after the injection of lipiodol into the petrous apex, showed the lipiodol to have escaped from the petrous pyramid into the subdural space, between the petrosa and the basilar process of the occipital bone.

Case 8.—Female, age 48, was admitted to the Beth Israel Hospital, service of Dr. Ralph Almour, March 26, 1931, with a diagnosis of petrositis, right side.



Fig. 10b. Case 7. Shows the probe which has been inserted into the fistulous tract to have entered the cavity in the apex. The apical destruction here is very clearly noticeable when compared to the opposite side.

Chief complaint: Pain over right temporoparietal region.

Radiographic examination by Dr. Frederick M. Law, March 18, 1931. Through the courtesy of Dr. Law, I am using his original films and submit his report, which is as follows:

The left mastoid is large and cellular and clear.

The right mastoid is postoperative.

All the cells have been removed, except for a slight suspicion of several minute cells over the auditory meatus. They are so small that it is really a question whether they are cells or cancellous structure. The remainder of the operated area appears to be clean.

The apex of the petrous pyramid on the left is clearly shown and is pneumatic almost to the tip. The petrous pyramid on the right is invisible from the internal auditory meatus to the apex.

Not having films made previous to the present attack, no comparison can be made, but it is very unusual to see such a difference in the two pyramids, and if there are any clinical signs



Fig. 10c. Case 7. The lipiodol which was injected into the fistulous tract is here seen to be located between the pyramid and the basilar process of the occipital bone, showing that a communication exists between the petrous pyramid and the subdural space.

referable to the apex, I would consider that this case represented absorption of the apex of the right petrous pyramid (Fig. 11 a).

Operation, March 26, 1931, right radical mastoidectomy and drainage of petrous tip. An erosion was found anterior to the superior semicircular canal and above the horizontal semicircular canal. The petrous tip was entered with a drill, the tip was found to be one large cavity, but no pus exuded from it. The fistulous opening above mentioned was widened and entered, and there was a flow of pus (about 2 drams). The cavity was curetted, and the pus continued to ooze. The fistulous tract led directly inward toward the internal auditory meatus.

Radiographic examination, March 28, 1931, after the injection of a drop or two of lipiodol into the petrous bone showed a few droplets of lipiodol in the apical portion of the right petrous (Fig. 11 b).

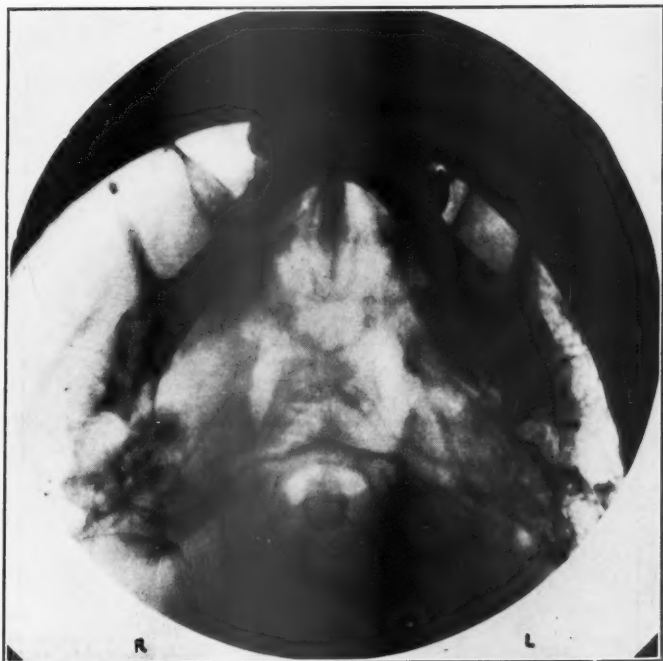


Fig. 11a. Case 8. This radiograph was made by Dr. Frederick M. Law. The left pyramid is clearly shown and is pneumatized to the tip; it shows normal aeration. On the right side the tip shows intense atrophy, with complete loss of trabeculation.

Case 9.—Female, age 8, had a left simple mastoidectomy on June 10, 1929. Following this the child had periodic attacks of pain through the left eye and dizziness. At one time she had a transient facial paralysis. The mastoid wound never healed and presented a discharging fistula. The middle ear also remained moist. The child was reoperated upon, but no cause could be found for the suppuration in the mastoid process. Under constant treatment, however, this lesion has eventually been cured.

This is one of the early cases in Dr. Kopetzky's series, and a radiographic examination made May 17, 1930, showed what probably was the source of the continued suppuration.



Fig. 11b. Case 8. The lipiodol injected into the right pyramid shows the droplets of lipiodol in the area of apical destruction observed in Fig. 11a. The intact pneumatized left pyramid is distinctly discernible.



Fig. 12. Case 9. The petrosae show extensive pneumatization. The right petrous bone is normally aerated. The left petrous bone shows a generalized diminution in aeration. The trabeculations are intact. The apex is intact.

The petrosae showed extensive pneumatization. The right petrous bone was normally aerated. The left petrous bone showed a diminution in aeration, with no destructive changes.

This case is of importance to the roentgenologist since it affords him additional means of determining whether a suppuration in the petrous pyramid is responsible for a protracted or chronic otorrhea following mastoid surgery. Kopetzky and Almour²⁹ feel that a definite relationship exists between a petrosal tip suppuration and a protracted aural discharge after surgery has been performed on a pneumatic mastoid process. Uffenorde³² states that one must think of a pyramidal tip suppuration where the middle ear continues discharging after surgery for the relief of an acute mastoid suppuration.

SUMMARY.

The most useful information in determining petrous pyramid suppuration is obtained by means of a base plate of the head (inferosuperior projection). From this view, pneumatization of the petrosa can be determined, changes in aeration are evident

and pathologic changes can be visualized.

Where roentgen findings are observed in a case presenting suggestive clinical symptoms of petrous pyramid suppuration, operative interference is indicated.

In addition, cases presenting a protracted aural discharge, following simple mastoidectomy on a pneumatic bone, should have the petrosæ radiographed to determine whether they are the cause of the chronicity.

It is advisable to radiograph the petrosæ as a routine procedure in every case of acute aural infection.

333 WEST END AVE.

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XXXVII.

THE SUPPURATION OF THE PETROUS PYRAMID:
PATHOLOGY, SYMPTOMATOLOGY AND
SURGICAL TREATMENT.*

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NEW YORK.

PART III.

SURGICAL THERAPY.

INTRODUCTION.

The therapy of suppuration of the petrous pyramid is surgical. How radical the surgery or what the manner of approach depends upon various factors which, in the main, cannot be generalized to cover the disease as an entity but must be specified to cover the entity as it occurs in the individual.

The objectives of any surgical procedure instituted for any suppurative focus are two-fold, to eradicate the focus and to prevent the extension of the disease. The eradication of a suppurative focus usually suffices to prevent the spread of the disease by the drainage afforded the pus and thereby permits the body's defenses to repair the damage done. However, drainage of the focus is not sufficient in itself to prevent the spread of the disease if the body resistance cannot successfully erect a pyogenic inflammatory wall to resist its onslaught. The extension from the original focus then results in a complication. Once this has happened, the surgeon must cope with the complication as well as the primary focus.

These general principles hold true for the application of surgical therapy to cases of petrosal tip suppurations. From what we have already stated, it is clear that we do not consider a petro-

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sal suppuration a complication of an acute mastoiditis. We consider it a complication of an acute purulent otitis media in the same way that we consider an acute mastoiditis a complication of an acute purulent otitis media. The fact that all our cases, as well as those reported in the literature, showed a mastoid suppuration does not preclude the possibility of an extension of an infection in the middle ear to the pneumatic space in the petrosa without an involvement of the pneumatic areas in the mastoid process. In referring to the anatomic factors in the first section of this paper, we showed the routes of infection to be from the middle ear, epitympanic space and antrum. It is therefore conceivable that an infection of the tympanoantral space may, because of anatomic conditions, spread into the pyramid and develop into an encapsulated abscess there while the infection in the neighboring mastoid cells heals spontaneously. Consequently, the line of surgical attack, to remove the original focus of suppuration in case of a petrosal tip abscess, must be one that will embrace the middle ear in its scope.

Since, however, the suppuration in the pyramidal apex is a complication of the original focus in the middle ear, the eradication of the latter alone does not suffice for the cure of the disease in most instances. The complication must also be treated.

There are exceptional cases where suppurative foci heal without surgical intervention. Here a drainage channel is established for the escape of the pus; and if there is a protective inflammatory reaction surrounding the focus which completely localizes it healing results. We have two cases of petrosal tip suppuration which fall in this category: both have been completely healed by a drainage channel established by nature.

HISTORICAL DATA.

In 1902, Streit⁵⁰ described a method of surgical attack for deep-seated epidural abscesses originating in a suppurative focus in the petrosal apex. After performing the necessary radical surgery on the mastoid process and tympanic cavity, he removed the upper wall of the external auditory canal as far inward as the tegmen tympani. The removal of the tegmen celluli and tympani followed, and the dura of the middle cranial fossa was then lifted

from the upper petrosal surface until the area of the Gasserian ganglion was reached and the pus evacuated.

In 1903, Goris,⁵¹ in a case of chronic purulent otitis media associated with diplopia, first performed a radical mastoidectomy and then made a trephine opening in the temporal fossa above the temporal line in the region of the external auditory canal. He then probed the middle fossa for pus but found none. A larger resection of the temporal bone was then made and the dura was lifted from the superior surface of the petrous bone. This exposure enabled him to identify and remove a sequestrum from the region of the petrous apex.

In 1914, Broeckaert⁵² described the supra-auricular approach to the pyramid tip in a case of Gradenigo syndrome. He made an osteoplastic flap above the zygoma and exposed the basis cranii. The dura was then freed until the petrosal tip was reached.

In their textbook on oto-rhino-laryngologic surgery, Moure, Liébault and Canuyt⁵³ recommend Broeckaert's method of approach for the Gradenigo syndrome.

In 1929, Mayer⁵⁴ described a case of Gradenigo syndrome following acute purulent otitis media wherein, after simple and radical mastoidectomy, a search was made for an epidural abscess by lifting the temporal dura to expose the tip of the pyramid. No purulent focus was found and signs of meningitis subsequently set in. It was then noted that the pus from the middle ear came from the region of the floor of the tympanic cavity. Accordingly, a wide exposure of the floor of the middle ear was made, after the technic of Piffi⁵⁵ for the exposure of the jugular bulb. This brought to view a large hole, located at the orifice of the eustachian tube, through which granulations protruded. The widening of this hole with a curette allowed a probe to pass forward and inward to the extent of 5 cm. from the knee of the facial nerve. Following the insertion of the probe a profuse amount of pus escaped and the patient recovered completely.

In 1929, Eagleton⁵⁶ described his operation for suppurations of the petrous tip, which he termed unlocking of the petrous pyramid. The principle of this procedure is the surgical reduc-

tion of the anatomy of the adult temporal bone to simulate that in the infant. A radical mastoidectomy is first performed, followed by the removal of what Eagleton terms the "anterior and posterior buttresses." In this manner the obstacles encountered in exposing the petrous apex through the middle cranial fossa are reduced to a minimum. The dura of the middle fossa is then elevated from the surface of the petrosa until the apex is reached. In addition, where Eagleton finds a tract indicating the avenue of invasion, he enlarges the opening and so uncaps it. He also mentions the translabyrinthine route of approach to the pyramidal tip as a possible method of attack.

In 1931, at the January meeting of the Section on Otology of the New York Academy of Medicine, Dr. Clarence Smith⁵⁷ reported a cured case of suppuration of the petrous pyramid which had ruptured subdurally and resulted in a deep-seated epidural abscess. He also attacked the purulent focus by elevating the dura along the superior surface of the petrosa until the pus pocket was reached and drained.

With the exception of Mayer's case, all of the surgical procedures above described attempt to reach the petrous apex through the middle cranial fossa. Some are modifications of the Gasserian ganglion operation; some are simply a wide exposure of the temporal dura in the course of a radical mastoid operation; others are a combination of the two. Except for Eagleton, who enters the petrous tip directly by means of a hook, none of those cited go beyond the exposure of the tip, so that if an epidural abscess is not present, their methods afford no relief from a suppurative focus within the pyramidal tip itself. On the other hand, a technic has been devised by one of us—Dr. Ralph Almour—which affords a safe means of entering the petrous apex through a radical mastoid cavity without opening the middle cranial fossa. This operation has been performed by both of us jointly and by each of us separately, and in every instance the pyramidal tip was entered and pus evacuated.

TECHNIC OF OPERATION.

Where a case of petrous pyramid suppuration has been diagnosed, either before or after surgery upon the mastoid process,

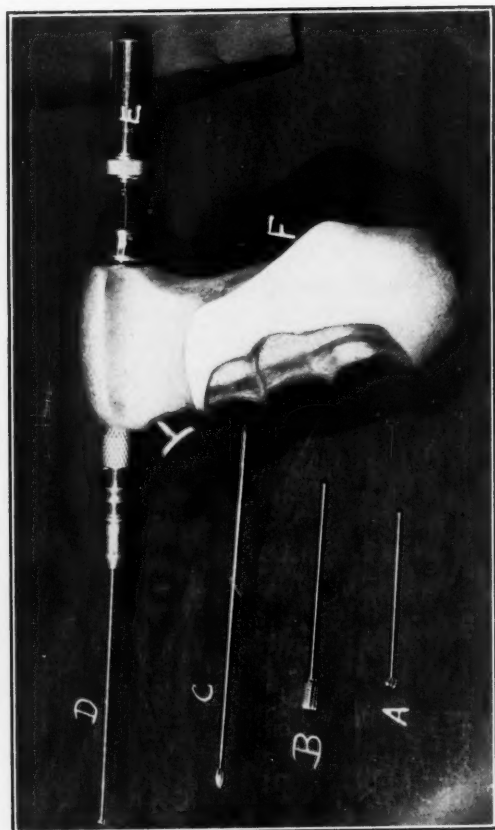


Fig. 7.

One-half actual size.

A and B. Moderate sized burrs for use with dental handle in thinning down anterior canal wall and zygomatic root.
C and D. $1\frac{1}{2}$ and 1 mm. burrs, respectively for entrance into petrous tip.
E. Dental handle with burr in place attached to Hurd pistol grip handle.

the inner table of the mastoid process must first be inspected. If no surgery has been done, a simple mastoidectomy is first performed. If this has already been done, the wound is laid open and all granulations removed. A careful inspection is made of the area beneath the posterior semicircular canal leading toward the jugular bulb and in the region of the solid angle to endeavor to find the path of invasion. The latter appears as a fistulous opening with granulations around the mouth. If it is probed, a flow of pus almost always follows.

The operative area is next converted into a radical cavity in the usual manner. After the toilet of the middle ear has been completed, the inner wall of the antrum and the epitympanic space are searched for a fistulous opening leading into the petrosa. The areas to be inspected particularly are the spaces directly in front of and behind the superior semicircular canal.

Upon the completion of the radical operation it will be noted that the anterior canal wall and the root of the zygoma form an overhanging obstruction to a full view of the eustachian tube. From without, these structures slope forward and inward toward the tubal orifice. The first step in the approach to the petrous apex is to obtain a full and unobstructed view of the tympanic orifice of the tube. Consequently, the removal of the overhanging anterior external auditory canal wall and zygomatic root must be undertaken. This is best accomplished with a moderate sized burr attached to the handle of a dental drill (Figs. 7A and 7B.). The anterior wall is thinned down as much as possible without opening into the glenoid fossa and the zygomatic root is removed to a level with the tegmen tympani (Fig. 8).

This preliminary work allows the orifice of the eustachian tube to be brought into full view. Inspection will now reveal the orifice of the tube and the cochleariform process containing the tensor tympani tendon. The latter is situated above the bony portion of the tube and forms its upper surface, extending backward along the inner tympanic wall as far as the facial knee. In cross section, it is 2 mm. in diameter and is separated from the eustachian tube partly by a thin bony septum and partly, on its lateral surface, by a fibrous membrane (Jacobson and Blau.⁵⁸) Thus it will be realized that in order to expose the true roof

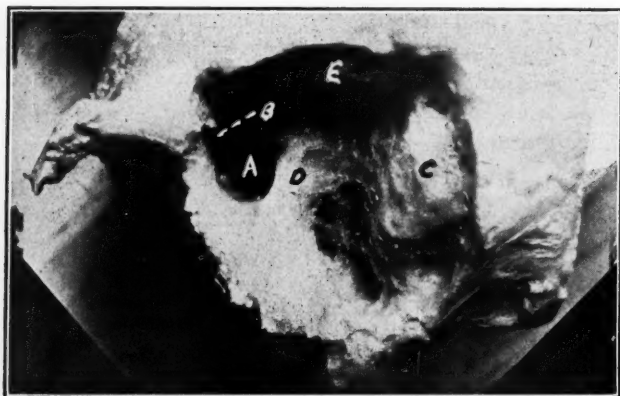


Fig. 8. A left temporal bone showing the preliminary steps completed before entering the petrous pyramid. The anterior canal wall has been thinned down and the zygomatic root has been removed. A, tympanum; at the upper anterior angle can be seen the orifice of the eustachian tube. B, zygomatic root. C, sinus plate. D, ridge for the descending facial nerve. E, Tegmen.

of the musculotubular canal it is necessary to remove the tensor tympani tendon and its housing completely. After this is done, an additional 2 mm. is added to the width of the tubal orifice. The second step in the preparatory work is the removal of the tensor tympani. This can best be accomplished with a small Spratt curette (size 0 or 00). The operative field then appears as in Fig. 8, except that the superimposed soft tissue is not present on the illustration.

In order to understand the method of entering the tip, it is essential to be thoroughly familiar with the anatomy of the cochlea, the internal carotid artery, the eustachian tube and the external auditory canal, for the avenue of approach is bounded by the three first named, and its direction is obtained by determining its angle with the last named.

Fig. 9 is an X-ray picture of a temporal bone, taken with the rays directed through the superior surface of the petrous bone, so that we are viewing the temporal bone from above. This picture demonstrates the avenue of approach and the desired

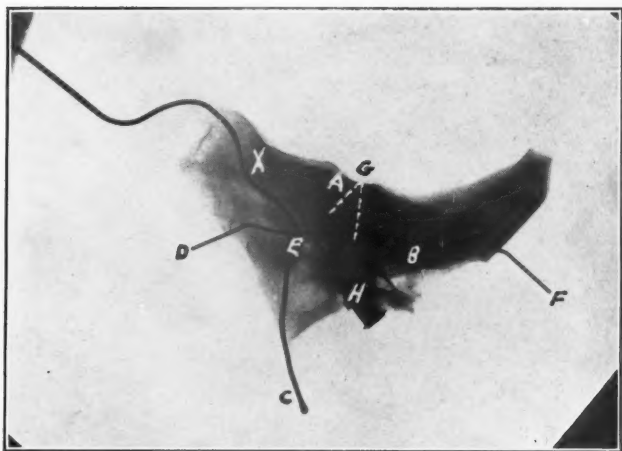


Fig. 9. Roentgenogram of temporal bone taken from above with probes in place to show direction of opening into petrous apex. A, postero-superior border of petrosa. B, squamous plate. C, probe in carotid canal. D, E, probe in eustachian tube extended backward to F to show angle made with H, probe entering through surgical avenue of approach to the petrous apex. G, cochlea and vestibule injected with lipiodol. X, petrous apex.

objective. At A is seen the posterosuperior border of the pyramid, at B the thin squamous plate. C is a probe in the carotid canal. D-E is a probe in the eustachian tube; E-F, the extension of the same probe. G is the cochlea, which has been injected with lipiodol. H shows the probe coming through the avenue of approach between the internal carotid, the eustachian tube and the cochlea, to reach the apex of the petrous pyramid at X.

From the foregoing, it is seen that the path of entry into the petrous tip which we employ lies between the cochlea, the eustachian tube and the internal carotid artery. In Fig. 10, the relationship of the basal coil of the cochlea to the internal carotid artery is diagrammatically represented. It will be noticed that the basal coil (1) approaches the carotid artery near the floor of the eustachian orifice and is in closest relationship with the artery where the ascending portion of the vessel begins to turn

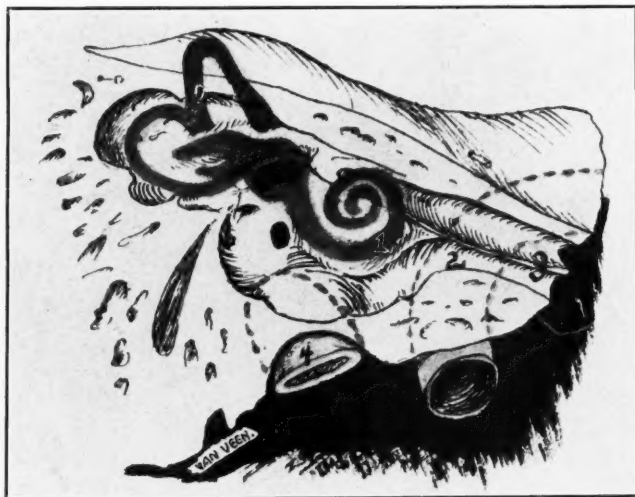


Fig. 10. Diagrammatic representation of relationship of cochlea, eustachian tube and internal carotid artery. 1, cochlea, basal coil; 2, carotid canal; 3, eustachian tube and canalis tensor tympani; 4, jugular bulb.

forward and inward in the carotid canal. Then, as the artery proceeds forward, the basal coil of the cochlea turns upward, so that at the level of the true roof of the musculotubal orifice the two are widely separated. In Fig. 11, the dissection of the bone has brought this out clearly. The probe is in the carotid canal, the external wall of which has been partly removed, along with the eustachian tube and the tensor tympani canal. The basal coil of the cochlea (1) is seen to protrude forward from the vestibule (2) and to come into direct contact with the inner wall of the ascending portion of the internal carotid canal, the distance between the two being 1 mm. (Schönemann⁵⁰). Where the inner carotid canal starts to bend forward (3), the basal coil is seen to turn upward (5), until, directly beneath the superior surface of the petrosa (4), the two structures are separated by a minimum distance of 6 mm. in fourteen specimens examined. The maximum distance noted was 9 mm., while the average for all fourteen specimens was $7\frac{1}{2}$ mm.

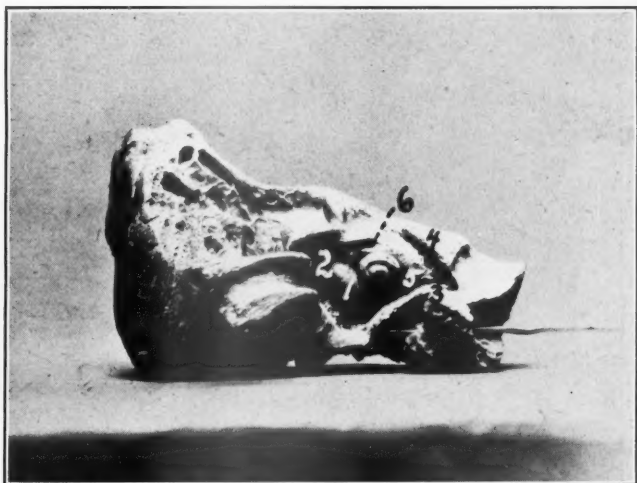


Fig. 11. Dissection of the right temporal bone. Eustachian tube and canalis tensor tympani removed. 1, basal coil of cochlea, proximal portion; 2, vestibule; 3, bend of bony carotid canal; 4, superior petrosal surface; 5, ascending portion of basal coil; 6, knee of facial canal.

If, in addition, it is remembered that the bony cochlea has an average thickness of 2 mm., it will be seen that the distance between the carotid canal and the ascending portion of the membranous basal cochlear turn—in other words, between the two vital structures—is increased by this two millimeters. In Fig. 12, 1 is the bony covering of the membranous basal coil (2). At 3 is the carotid artery. Directly under the superior petrosal surface (4) the distance between the carotid and the osseous basal turn (1-3) is a minimum of 6 mm. Between the carotid and the membranous basal coil (2-3) this distance is increased by the width of the bony basal coil, namely, by 2 mm.

The relationship between the eustachian tube, the carotid artery and the cochlear turns is best understood by reference to the white metal preparation shown in Fig. 13. This has been photographed so that one is viewing the specimen from above. At 1 are the eustachian tube and the tensor tympani canal. The carotid

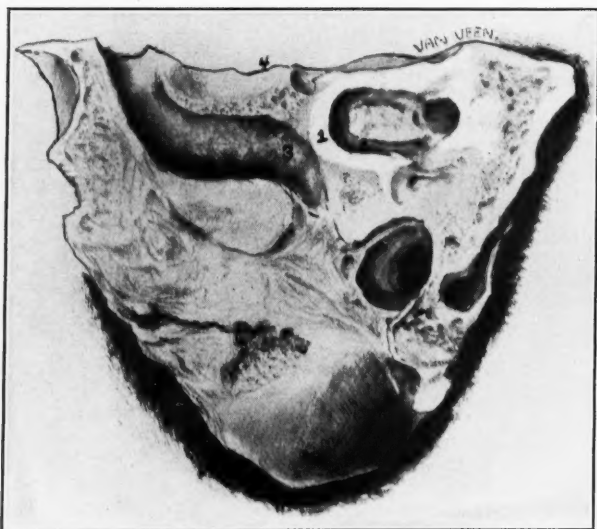


Fig. 12. Specimen cut through the long axis of the carotid. 1, osseous basal cochlear turn; 2, perilymphatic space of basal coil; 3, inner wall of carotid canal; 4, superior surface of petrosa.

artery is seen at 2 and the cochlea at 3. The superior surface of the petrous bone has been removed in this preparation to enable one to see the relationship between the three structures. It will now be seen that a pyramidal space exists between them, through which we have been able to enter the petrous tip at X. The apex of this pyramid is situated downward and is formed by the convergence of the basal coil of the cochlea, the lowest portion of the inner wall of the osseous eustachian tube and the bend of the carotid artery in its canal. Its base is formed by the superior petrosal surface. The anterior wall is formed partly by the inner wall of the eustachian tube and partly by the inner wall of the canal for the tensor tympani muscle. The anterior wall is formed by the portion of the carotid canal which runs forward and inward. The inner wall is formed by the three cochlear turns.

On carefully studying Fig. 13, it will be seen that if an entrance is made through the pyramidal space above described near the



Fig. 13. Cast of the right temporal bone. The superior petrosal surface has been removed. 1, eustachian tube and canalis tensor tympani; 2, carotid canal; 3, basal coil of cochlea; 4, superior semicircular canal; A-B, direction of line joining apex of cochlea and basal coil; X, petrous apex.

base of the pyramid—i. e., directly under the superior surface of the petrosa—the tip of the petrous pyramid can be reached, provided the direction of entry parallels a line drawn between the apex of the cochlea and its basal coil (A-B). The exact location of the cochlear apex is directly behind the inner wall of the canal for the tensor tympani muscle, being separated from it by a distance of $1\frac{1}{2}$ -3 mm. (Seibenmann⁶⁰). It must be remembered, however, that the canal for the tensor tympani extends well backward along the inner tympanic wall to reach the facial knee. The cochlear apex is in relation to that portion of the canalis tensor tympani which is located in the tympanum, posterior to the orifice of the eustachian tube. The width of the apical turn measures 3 mm.; that of the middle turn 4 to $4\frac{1}{2}$ mm.; and that of the basal winding 7 to $7\frac{1}{2}$ mm.⁶¹

When viewed from above, the eustachian tube forms, with the sagittal axis, an angle of 45 to 50 degrees, which opens postero-

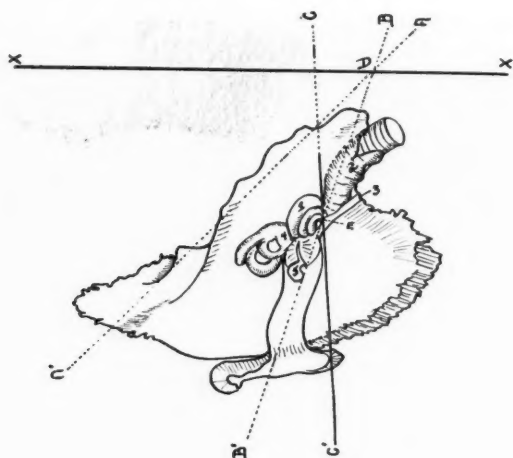


Fig. 14. Semischematic drawing of right temporal bone to show determination of point and angle of approach to petrous apex. A-A1, axis of postero-superior border of petrous bone. B-B1, axis of external auditory canal. C-C1, axis of surgical approach to petrous tip. X-X, median sagittal plane. Angle A1 D X = 45 degrees. Angle B1 D X = 75 degrees. Angle B1 E C1 = 22 degrees. 1, cochlea. 2, carotid canal. 3, eustachian tube. 4, vestibule. 5, malleus.

externally (Lincke⁶²). With the axis of the external auditory canal it forms an angle of 135 to 140 degrees, which opens anteroexternally. The bony external auditory canal axis forms an angle of 75° with the medial sagittal plane, opening backward (Schwalbe⁶³). The angle made by the posterosuperior border of the petrosa with the medial sagittal plane is 45 to 50 degrees. In estimating the direction of the line joining the tip and the basal coil of the cochlea, in the fourteen specimens examined it was found that this line formed an angle with the posterior superior border of the petrosa measuring 35 to 40 degrees, the angle opening backward.

Utilizing the above figures and measuring the angles accordingly, we find that an instrument, placed directly under the roof of the eustachian orifice after the tensor tympani has been removed and directed at an angle of between 20 and 25 degrees

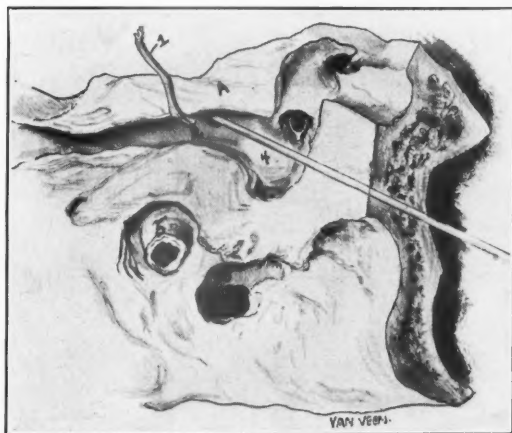


Fig. 15. Left temporal bone prepared to show point of entrance to petrous apex. Viewed from side. The probe enters through the surgical approach to apex. 1, tendon of tensor tympani left in situ. 2, tympanic orifice of eustachian tube. 3, stapes. 4, promontory. 5, internal carotid artery before entering carotid canal. 6, jugular fossa.

to the axis of the external auditory canal, will enter the pyramidal space between the cochlear turns, the eustachian tube and the internal carotid artery and reach the apex of the petrous pyramid. The determination of these measurements is shown in Fig. 14. Fig. 15 shows a probe in place at the point of entrance. Fig. 16 is the same specimen, viewed from above, and shows the probe passing between the cochlea and the internal carotid canal to reach the petrous tip. Fig. 17 is still the same specimen. Here the bony overhang seen in Fig. 15 and Fig. 16 has been removed and the groove between the cochlea, the carotid canal and the tube (all of which have been opened) can be seen. This groove constitutes the pathway of entrance to the tip. Fig. 18 demonstrates the completed procedure on the cadaver from which the temporal bone was subsequently removed for use in the illustrations Figs. 15, 16 and 17. The upper probe is placed in the opening into the petrous apex, while the lower probe is in the eustachian tube.



Fig. 16. Same specimen as in Fig. 15, viewed from above. 1, bony cochlea. 2, internal carotid in canal. X, petrous apex. Probe is seen to pass in groove between cochlea and carotid to reach apex of pyramid. A, bony overhang which in the next illustration has been removed.

The opening into the tip is best made with the aid of a 1-1½ mm. burr, as shown in Fig. 7 (c and d). This is attached to a dental drill handle which is held so that it forms an angle of 20 to 25 degrees with the axis of the external auditory canal. The burr is placed as high up as possible, directly at the mouth of the eustachian tube. A gentle but firm pressure is required to hold the burr in place while the motor is going. After drilling for a distance of 3-5 mm., the operator gets the sensation of suddenly entering a cavity. He should then stop drilling and with a fine blunt probe go through the opening into the tip. An escape of pus usually follows the opening with the burr. It always follows manipulation with the probe, which breaks up any granulations within the petrosa.

In the performance of this technic for drainage of the petrous tip we have at no time encountered any difficulty in entering the apex nor have we had any untoward surgical accidents. The point of entrance is situated well anterior to the facial knee and above the promontory. Theoretically, the close proximity of the carotid canal might lead one to believe that this structure could



Fig. 17. Same specimen as Figs. 15 and 16. The bony overhang seen in Figs. 15 and 16. A, has been removed.

1, eustachian tube. 2, bony cochlea which has been opened to show perilymphatic spaces. 3, carotid artery in canal, the superior wall of which has been removed. 4, incus. 5, stapes. 6, malleus with portion of drum attached. A, point of surgical entrance in middle ear. B, pathway of approach to tip of petrosa between cochlea and carotid canal. 7, mastoid process.

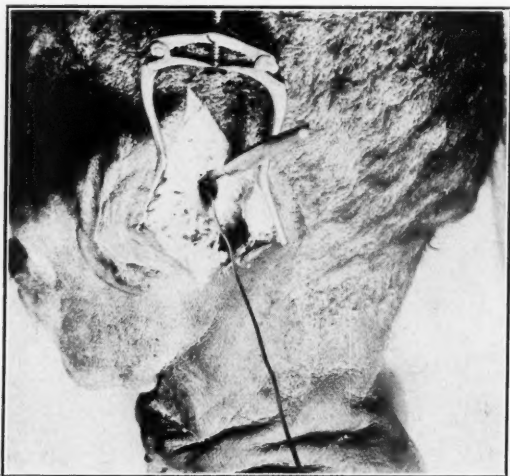


Fig. 18. Completed operation on cadaver. Lower probe in eustachian tube. Upper probe in entrance to opening into petrous apex.

easily be injured. Actually this could happen only if the entrance to the tip were effected at a point below the designated one. If it is remembered that the uppermost portion of the knee of the carotid canal is situated well below the level of the true roof of the musculotubular canal at the tympanic tubal orifice, it is plain that the burr will not encounter the carotid if it is placed as high up as possible at the mouth of the eustachian tube.

In none of our cases was there any injury to the labyrinth. None of the cases had any symptoms referable to a purulent, traumatic or even serous labyrinthitis. Injury to the membranous cochlea is possible with this method of drainage of the petrous apex only if the technic described is not scrupulously followed.

INDICATIONS FOR THE TYPE OF SURGERY REQUIRED.

Where there exists the symptom-complex described in Part II of this paper, surgery should be employed for the relief of the deep-seated suppurative focus within the petrous apex.

Where, in addition to the above, the roentgenological examination shows that the apex has retained its contour, the surgery employed should be one of the two following procedures.

A. If the pathway into the tip has been located after a radical mastoidectomy has been performed, this fistulous tract should be widened, curetted and probed to its depth. If a flow of pus follows this procedure, the tract should be drained with a thin piece of rubber dam for a few days and then injected with lipiodol. The latter procedure not only affords us with an excellent photograph of the tract into the petrous tip but, in the two cases in which we have used it, has had a curative effect in completely sterilizing the suppurative focus.

B. If, after probing the tract, there is a failure to obtain pus, or in the event of not being able to discover the pathway of entrance, the technic described by us for drainage of the petrous tip should be employed to evacuate the pus within the petrous apex.

Where, in addition to the clinical picture of petrous pyramid suppuration, there are also signs pointing to an epidural abscess, or where the radiographic examination reveals a break in the contour of the petrous apex, the epidural abscess should be drained by the subdural route, employing any of the methods described (Striet, Goris, Broeckaert, Eagleton, Smith).

Where, after simple mastoidectomy on a pneumatic bone wherein the causative factor was not an acute necrotic otitis and wherein there has been no secondary cholesteatome formation, a chronic otorrhea results, where, in addition, the roentgenogram shows definite evidence of disease in the petrous pyramid, here the surgical technic described by us may be employed to eradicate the disease in the petrosa which we feel to be the cause of the chronic otorrhea in such cases.

(TO BE CONTINUED.)

51 WEST 73RD STREET.

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XXXVIII.

AN AURAL SYNDROME OF HEPATIC ORIGIN.*

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BOSTON.

The following study is the outgrowth of a series of observations made in connection with a general diagnostic service in which emphasis is laid on the diseases of the ductless glands. The theory of operation of this service has been to base the initial study on a thorough physical examination, a carefully complete medical history and a series of standardized laboratory procedures. This basic study is supplemented by additional measurements, observations or clinical studies which may be suggested by the data of the first part of the examination. As may be anticipated, where a large number of cases are receiving so thorough and comprehensive a survey, individual points, in themselves of seemingly minor importance, recur with a sufficient frequency to attract attention. A correlation of the occurrence of any one of these with all of the other data of the cases presenting it may bring to light a fact of etiologic significance or diagnostic importance.

In the present instance all cases presenting to the diagnostic service giving a history of a possible impairment of aural acuity, of disease of the ear or other consideration dealing with the organ of hearing, or who in the physical examination demonstrates the actual or possible presence of any one of these, is given an audiometric study as a part of the examination. As this operation is a routine and the selection of the case made by the examining physician, the aurist who ultimately passes on the audiometric record plays no part in the initial selection. For this reason,

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†From the Evans Memorial.

then, the series assumes an especial significance inasmuch as they compose a sequential series on whom ear studies have been made.

The use of the audiometer under proper conditions has been of great use and value in the study of these ear disturbances. By its means the measurements assume a certain degree of objectivity, as the threshold is approached from both directions and the devices controlled by the operator give real evidence of an inhibiting inco-operation and an equally destructive overwillingness. Furthermore, the audiometer in its several forms plots what may be designated as the spectrum of hearing, an entity that may be regarded, without to great a strain on the imagination, as analogous to absorption spectra in the field of light.

In dealing with one of the special senses it is most essential to scrutinize the individual history most closely, as it is only through the latter, in combination with the objective findings, that we are able to arrive at a diagnosis and to determine the prognosis. It will be noted that the majority of patients, however, are not able to inform us, even approximately, as to the commencement of their deafness. This in part is due to the fact that as much as 50 per cent hearing acuity of one ear may be lost before the individual is conscious of any defect. This is especially true of those unilateral, insidious affections which run their course without subjective symptoms, as well as to those bilateral conditions in which the disturbance of hearing interferes with their usual occupations.

General diseases of the body affect the hearing acuity more than any of the other special senses because the eighth nerve is extremely sensitive to infection or circulatory toxemias. This point, I believe, is not borne in mind sufficiently and time is allowed to lapse before active corrective treatment is instituted. Dr. Gottlieb¹ of New York some time ago did some very interesting work along this line, but seemingly felt that the pancreas rather than the liver was the important etiologic factor.

In our analysis of this long series of cases for possible correlations it was found that a very high percentage of those patients with hepatic dysfunction either reported loss of hearing or were found to be partially deaf during the general physical examination. Further study of the audiograms demonstrated that in

addition to a demonstrable general lowered acuity of hearing there was a characteristic additional loss at 4096 d. v. frequencies, somewhat resembling the curve earlier reported by the author² as frequently found in syphilis.

This report deals with a consecutive series of 120 cases, all of whom had a proven hepatic dysfunction and upon whom audiometric studies had been made. The primary composition of the group is the common incidence of demonstrated hepatic dysfunction. Many of the patients, however, showed significant complications, certain of which could modify the clinical and laboratory picture of the individual case. The more important of these disturbing factors are grouped in the following table:

TABLE I.
SIGNIFICANT COMPLICATIONS.

Endocrine	Number	%
Thyroid	26	21.7
Pituitary	10	8.3
Ovarian	5	4.3
Pluriglandular*	1	0.8
Gall bladder.....	39	32.5
Focal infections.....	72	60.0
Psychoneurosis	16	13.3
Cardiorenal.....	46	38.3
Lesions of central nervous system.....	14	11.7
Syphilis	10	8.3

*A male castrate with thyroid failure.

An appreciable number of the cases presented a definite endocrinopathy. The thyroid is most frequently encountered, an association between hepatic dysfunction and hypothyroidism having been reported in the literature. The sole pluriglandular case was also a thyroid failure, the plural character of the diagnosis resting upon a castration some thirty years earlier.

One-third of the liver cases had associated gall bladder pathology and one-half severe focal infections with tonsils, sinuses, appendices and pulmonary tuberculosis as the principal foci. Psychoneurosis affects the report of tinnitus; syphilis the shape of the audiometric curve. Altogether, enough complications are recorded of possible significance in the picture to offer an average of two per case.

The relations of sex and age are collected in Table II:

TABLE II.

SEX AND AGE

Group	Sex		Age (Years)	
	Male	Female	Male	Female
Thyroid	11	15	38	40
Pituitary	2	8	33	45
Gonad	0	5	0	53
Pluriglandular	1	0	67	0
Nonendocrine	25	53	48	43
Total or average.....	39	81	46	45

The females outnumber the males two to one, a not infrequently reported ratio in many medical relationships. It seems safe to say that factors other than the incidence of disease influence this apparent sex disparity. The age average of the sexes is closely correlated, and while the groups and the individuals composing them show some scatter, the majority of the patients were middle aged. The character of the primary pathology is undoubtedly a factor in determining this datum.

In a review of the medical history certain of the reported symptoms are presumptively referable to the liver, others associated with the ear condition. A few others, as fatigue and vertigo, are recorded in both. The more significant, with their incidence in the series, are collected in the next table:

TABLE III.

SYMPTOMS.

Hepatic		
	Number	%
Headache	66	55.0
Jaundice	27	22.5
Nausea	28	23.3
Vomiting	26	21.7
Flatulency	40	33.3
Constipation	44	37.3
Diarrhea	4	3.3
<hr/>		
Aural		
	112	93.3
	57	47.5
	39	32.5
	28	23.3
	16	13.3
	10	8.3
Bárány test (negative).....	88	73.3

One-half the series have headaches (intestinal migraine) and nearly one-fourth an earlier record of jaundice. Constipation is the common report, but four of the cases reporting diarrhea. As the ear problem is our chief concern, the data bearing on the second group of symptoms may receive more extensive consideration.

Headache, while recorded under hepatic symptoms, is also related to the ear condition. In this series of cases there seems to be a constant sensation of swelling and pressure inside the head. The headache frequently awakens the patient in the very early morning and occasionally lasts throughout the day. Oftentimes the patient rather dreads going to sleep at night, fearing a siege of headache in the morning. There is generally marked fatigue accompanying the headache and it increases during the day. When both of these symptoms are marked there is distinct watering of the eyes and a desire to be alone and in the dark. At times the headaches are very disabling, beginning in the occipital region, then coursing over and through the head to the frontal region. Again, they may simply involve the frontal and parietal regions. During the intense headache the mouth usually tastes badly and oftentimes there is some nausea and flatulency. The tongue is usually coated with a white exudate that is liable to be ropy in character.

All but eight of the patients reported or demonstrated deafness which in type is not characteristic. Therefore, there is no point of special interest regarding the hearing tests except that generally the bone conduction is shortened. The hearing tests conform to the type of deafness of the special case. For instance, the drums may be perfectly normal in appearance, there may be a slight retraction, a certain dulling of the transparency or a break in the cone of light to a slight retraction of the drum. In the thyroid failure cases one may note at various times of observation swelling of the lateral pharyngeal walls and a tube equally swollen with possibly rales heard at the time of inflation. This condition is usually transitory and is like the infiltration of tissues seen at other parts of the body in thyroid dysfunction.

When the internal ear seems to be involved the hearing tests are consistent with the condition. The involvement is much bet-

ter shown by the audiometer, as the deafening noted is above the ordinary speech area. There is never mastoid involvement and the appearances of middle ear suppuration are incidental and not causative. Either ear may be involved, at times both. The point of consistency apparently is the low grade auditory nerve infection (toxic) with no typical middle ear involvement. It is generally very slow in development. If there seems to be any tendency to a hereditary influence, I think the only connecting link is a metabolic susceptibility which is noted in certain families.

Tinnitus.—The noise is in the ears directly and not indefinitely in the head. Generally if not always, it seems to have a wave characteristic with only a single subjective noise; occasionally, however, a wide variety of noises appearing simultaneously is reported. The wave is not constant in its intensity, which is due to the physical condition of the individual. When there is a direct blood stream infection (toxemia) the tinnitus is constantly greater. It also generally lessens as the deafness increases in amount. A high pitched tinnitus indicates increased tension in the middle ear, while a low pitched form suggests a vascular involvement. A rushing tinnitus suggests venous congestion and is noticeably worse on lying down. This point is very distinct in this present syndrome. Also, in this grouping of a large number of cases the intensity is very uniform, the individual variations being unusually slight. It is also noted that free evacuation of the intestinal tract relieves and softens the tinnitus.

Fatigue.—The fatigue element is probably more connected with the endocrine dysfunctions than with the primary conditions. The other associations are possible, however. The type of fatigue is variable, all of the characteristic endocrine idioms being reported.

Vertigo.—Vertigo is one of the most sudden and distressing symptoms that the human body experiences, yet the location of the cause is still obscure. This in part is due to the intermittent character of its manifestation, and in part to a lack of clarity of definition to the condition to which the patient applies the term vertigo, dizziness or giddiness. While we have been accustomed to regard the symptom as vague and lacking outline, the fact remains that it must be caused by a direct inhibition of the labyrinthine semicircular canals. In this series of cases the outstand-

ing symptomatic type was usually giddiness or a confusion, while dizziness generally connoted the definite sensation of a change in equilibrium and possibly a desire to fall over. Oftentimes simply reclining with the eyes closed will stop the surging as well as the intense tinnitus.

Bárány Test.—Under this caption were eighty-eight cases that to complete the diagnosis received the test, and all proved to be within normal reaction time. The chair was used in each case, and eighteen were tested in the three positions with negative results. The caloric test was not used, as none of the cases showed any intracranial symptoms.

The supporting evidence upon which the diagnosis of hepatic dysfunction rests must not be neglected. A series of reports to the basic condition are grouped in Table IV :

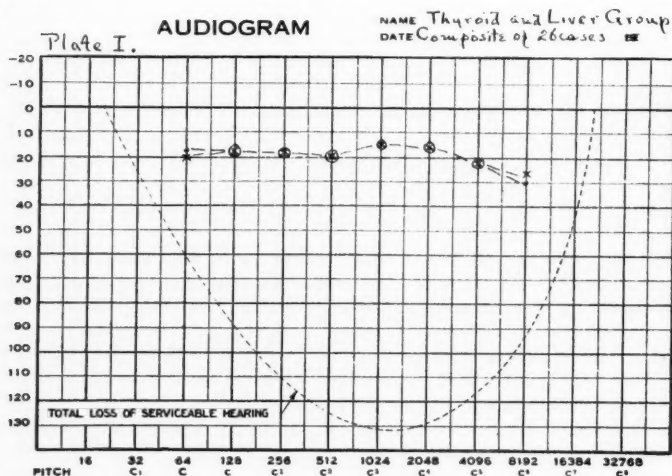
TABLE IV.

LIVER DATA.

X-ray Findings	Number
Graham, plus	32
G. I. Series, plus.....	36
Liver function, plus (McClure).....	102
Operation History—	
Cholecystectomy	8
Appendectomy	18
Other Laparotomies.....	7
Physical Examination—	
Abdominal tenderness, enlarged liver, etc.....	57

About one-fourth of the cases showed positive Graham tests and about the same number some pathology in the gastrointestinal series. Defects in filling of the duodenal cap and pathologic appendices were the two common findings in the latter. Eighty-five per cent of the entire group gave positive evidences of hepatic derangement by the liver function test (McClure), using the duodenal tests. The operative history recorded significant facts in a few cases; the physical examination, in nearly 50 per cent. The liver status was well documented with objective data throughout the series.

Turning to the ear conditions, these can best be discussed from the composite audiograms assembled for the several groups. As



endocrine conditions also affect aural acuity, each major section has been considered separately. Other conditions possibly affecting the audiograms are scattered throughout the entire series. Their influence would be so divided as to be without important influence on any single group.

Plate I represents the air curve as a composite of the twenty-six cases of thyroid disease complicated with liver dysfunction.

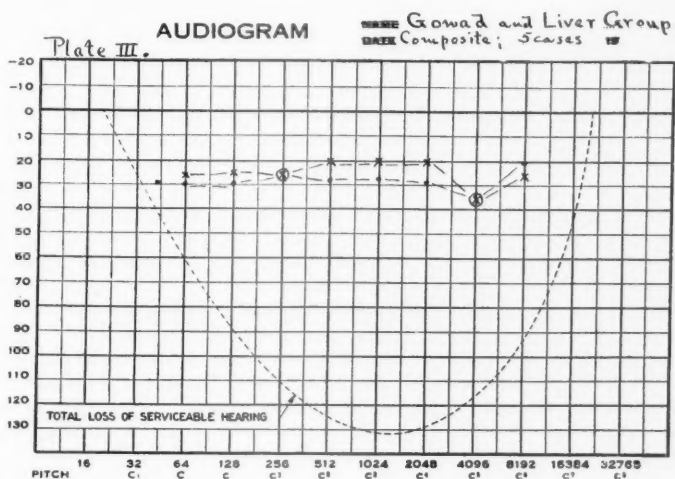
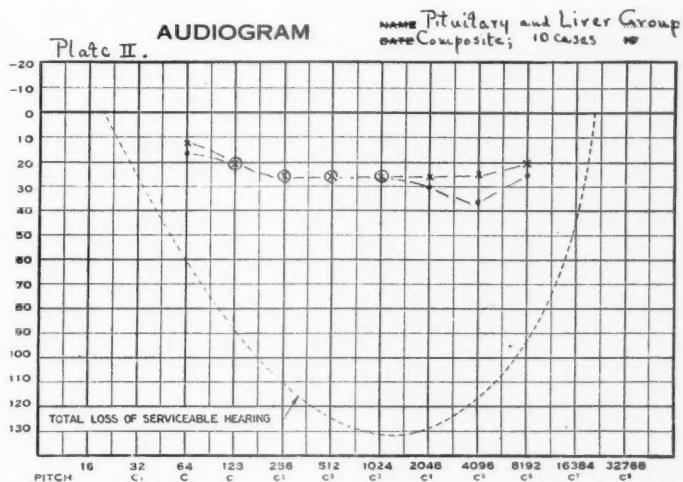
It would seem that the thyroid affects the curve at the upper frequency with a gradual drop from 2048 d. v.

Plate II represents the air curve as a composite of the ten cases of pituitary disease complicated with hepatic dysfunction.

It seems that both ears parallel each other except at the upper frequencies. That there seems to be a general bowing upward toward the average line (within twenty sensation units) is suggested.

Plate III represents the air curve as a composite of the five cases of ovarian failure with hepatic dysfunction.

It is suggestive that the general lowering of the curve may be due to a greater metabolic depression in this group of cases. The curve also shows a distinct lowering at 4096 d. v.



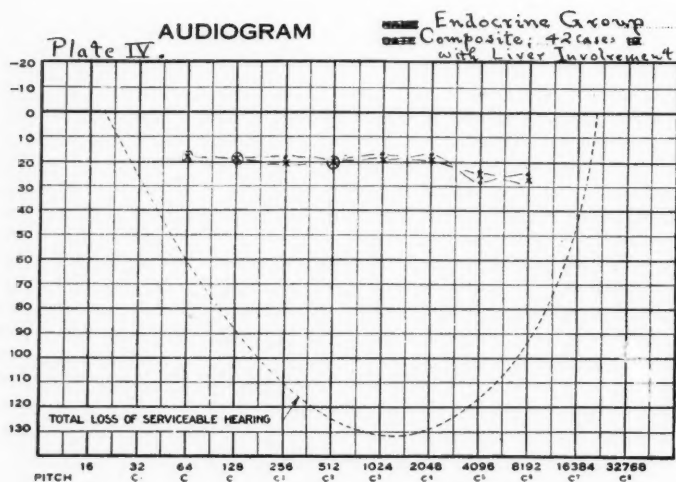


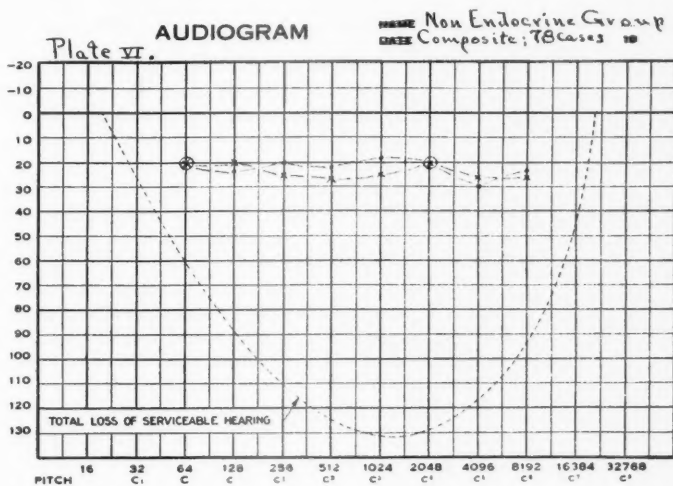
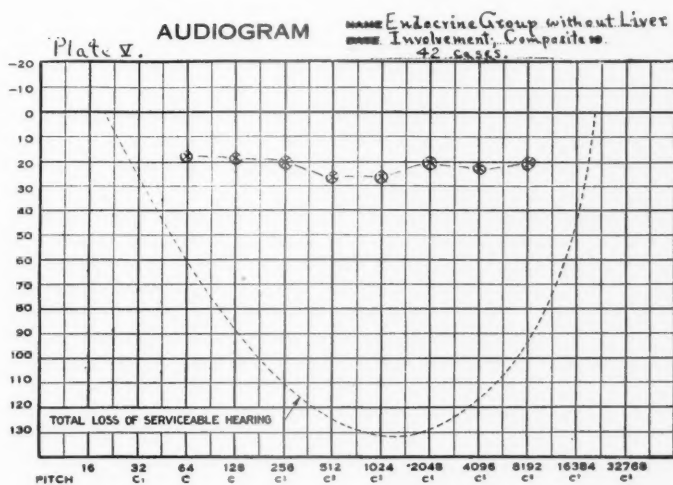
Plate IV is a composite curve of air conduction of the forty-two cases of the endocrine group.

It would seem to indicate a general lowered nutritional level throughout the several frequencies which has so often been observed in conditions with a toxic background.

Plate V is a composite curve of an endocrine group of cases that showed no liver complications, forty-two in number. The only comment would seem that at the higher frequencies there is a slightly greater depression of aural acuity.

Plate VI, a composite air curve of the seventy-eight cases of nonendocrine disease follows:

The general contour of the curve shows that the left ear seems to be the better of the two ears. It also shows a slight depression at 4096 d. v., with a tendency to recover at 8192 d. v. The entire gram is practically below the average area of good hearing.



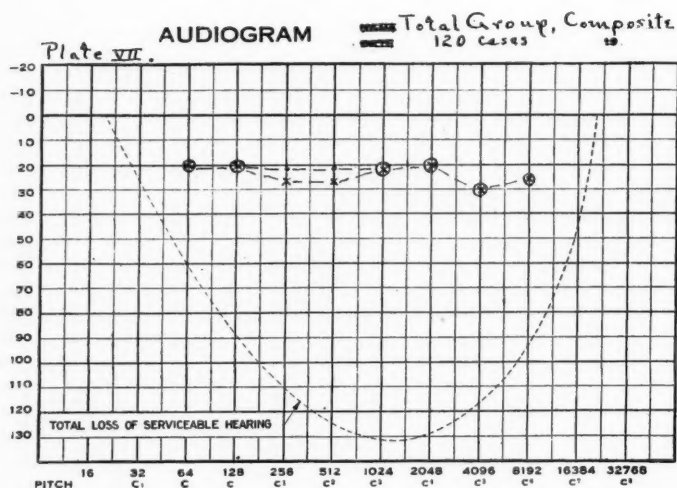


Plate VII is the composite curve for air conduction of the entire group of 120 cases of deafness complicated with hepatic dysfunction. It would seem to bear out in a graphic way the general thesis and shows the dipper gap at 4096 d.v. There is also slightly better hearing in the left ear, especially in the general speech area.

DISCUSSION.

Where there is functional derangement the morbid changes may develop so slowly and insidiously that neither the patients nor their friends become alive to the situation until some symptom manifests itself in an unmistakable manner. The lowered metabolism affects the vegetative functions, possibly causing irritability and depression, reflex gastric and intestinal disturbances, vague malaise as well as skin conditions and pains throughout the body.

It has been demonstrated that a single gland may manifest overactivities and underactivities at different periods of its functional derangement. Dysfunctional types are also recognized. It is, however, the borderline case that raises our particular interest, and, generally this is the type met with in this syndrome. The subject of glandular hypofunction is never fit, is generally

tired, finds any work a burden, and whether employment is physical or mental, requires a great effort to overcome disinclination to take up a task. Again, the mental apparatus fails, memory is unreliable, one cannot recall either recent or past events, attention wanders, and in a word, the patient is as sluggish mentally as he is languid physically.

In the general outline above mentioned the otolaryngologist will probably find a number of physical changes locally that will suggest a liver dysfunction together with or without a gland failure. The otoscopic examination failing to explain the symptoms he may find on further exploration that the lateral walls of the pharynx are red, swollen and bathed in a tenacious secretion, that the capillaries of the pharynx are unusually prominent, that the tongue is furred, that the voice is husky and the lingual tonsil varixed and on inspection the nose may show boggy inferior turbinates with or without enlargement of the posterior ends.

He then realizes, on closer inspection, that the headache, deafness, tinnitus, the vertiginous symptoms, flatulency and constipation all fit in together like a picture puzzle and he at once begins a more rigid physical examination. These above mentioned symptoms may be present in a greater or lesser degree depending in part whether the patient is found to be endocrine or nonendocrine. The proper diagnosis influences the outcome of the individual case. It should be borne in mind that local treatment of the ears, nose, and throat is not sufficient but must be supplemented with the correct treatment for the hepatic disturbance as well as balancing the endocrine symptomatology if it is found to be present.

The following case protocols may be illustrative:

Case 1-A.—A married man, age 56 years, head of an industrial organization, complained of severe frontal headaches, tinnitus and deafness, from which he had suffered for the past ten years. These symptoms have been associated with attacks of vertigo, during some of which the patient has fallen. Twenty years ago he developed tinnitus in the right ear for a short time and this recurred at intervals since that time and was accompanied by nausea and vomiting. The attacks recurred at two or three-month intervals and were associated with progressive loss of hearing, more marked in

the right ear. Three years ago the tinnitus ceased, as did the nausea and vomiting. The severe frontal headaches have persisted, manifesting themselves after the patient had gotten at work, even though he had felt perfectly well up to that time. A few minutes' rest in a horizontal position relieved all symptoms. If the attack occurred while walking, he experienced some vertigo and a sense of insecurity. He might fall, but recovered in a few minutes. There was no frothing at the mouth or loss of sphincter control. His family history does not seem to be relevant. He had been married for 21 years, his wife had one miscarriage during the first year of the marriage, and had never conceived again, although contraception has not been practiced. He recorded several minor ailments: scarlet fever, quinsy, sore throats, a blow on the head at the age of seven years, with tenderness persisting for a year. At the age of 21 years he was thrown from a carriage, breaking two teeth. His remaining history showed slight dyspnea on exertion, constipation of 40 years' duration, though for the past few days the bowels have relaxed. There was a slight ataxia.

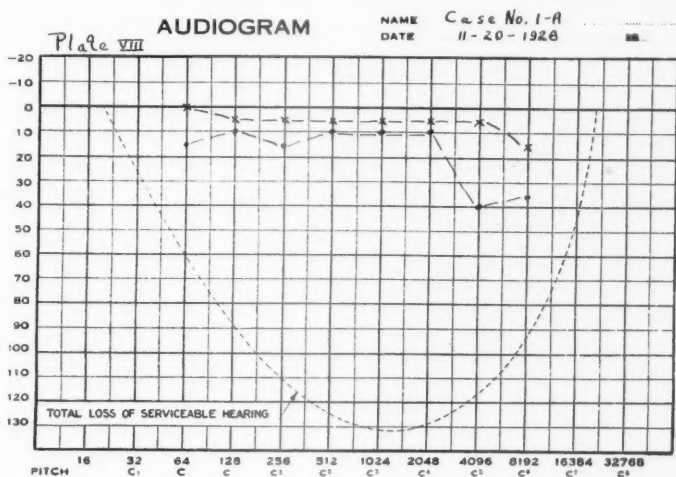
Physical examination showed an obese man, with florid complexion, some dilatation of the scleral vessels, the left ear was normal, while the right showed a retracted drum, and the audiogram illustrates his hearing. There was some cyanosis of the lips, the teeth showed much dentistry; the heart and lungs were apparently negative. There was a thick pad of abdominal fat. He had some clubbing of the distal interphalangeal joints of all the fingers; there were two areas of skin pigmentation over right tibia and three on left. The knee jerks were hyperactive. The urine volume was distinctly above the normal; elimination was high and the balance very poor. His protein intake was entirely inadequate, but the partition formula was normal. A small amount of albumin was reported. The blood morphology was substantially normal, with the exception of 3 per cent eosinophilia. The blood chemistry showed a high uric acid. The serologicals, including the results of a spinal puncture, were normal. Both phthalein and CO₂ were normal. The patient was 38 per cent overweight and appreciably below his predicted lung volume. The basal rate was —31 per cent, with normal findings. X-ray showed prominent

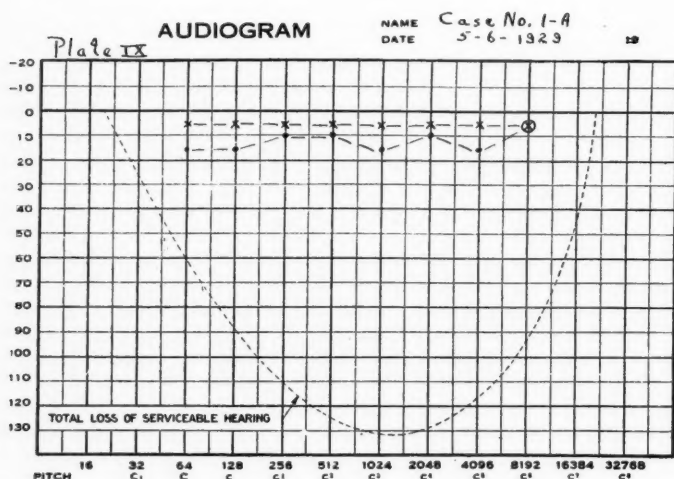
diploic veins and a retained root which was not infected, while a gastric series was negative. The neurologic examination was suggestive of a labyrinthitis with a partial destruction of the end organ. The eye examination showed a moderate vascular sclerosis, yellowish discs, and slightly hazy lenses, but was otherwise substantially normal. The Bárány entirely eliminated an acoustic neuroma, leaving the suggestion only of an infiltrating edema of the eighth nerve. The galactose test was normal; he reacted positively to a number of proteins by the endermal method.

Diagnosis: Thyroid failure with hepatic dysfunction.

Under proper treatment he improved slowly but very markedly as the following two audiograms will suggest.

Case 2-B.—A married woman of thirty-five, with a happy home life and two normal children, interested in everything social and otherwise, for a period of several years has had indefinite pressure through the forehead. She has been treated in many ways, endeavoring to control the tinnitus, which causes nervous instability with melancholic outbursts which are becoming more intolerable. Her past history is not remarkable except that she was sent to Asheville for tuberculosis. She records a few minor ailments, several attacks of tonsillitis, and the removal of her appendix as well



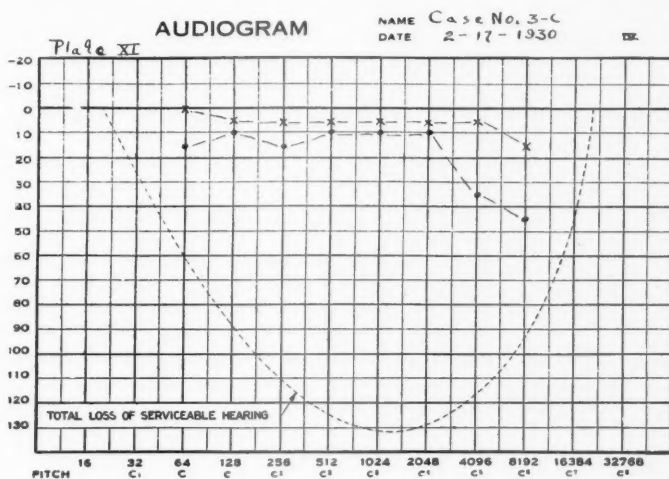
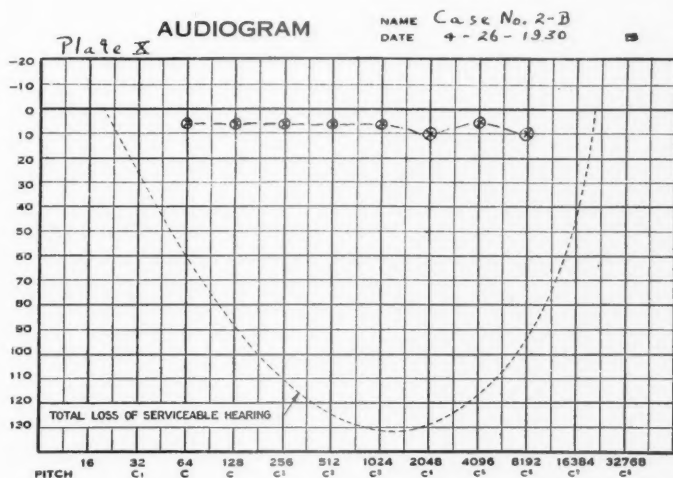


as a ventral fixation. At times she has been markedly jaundiced as well as being habitually constipated.

Physical examination notes a possible ptosis of the eyelids, imbedded tonsils and soft, poor teeth. The urine volume is ample, elimination fair, balance fair, remaining examination negative. Protein intake is far from liberal, partition formula is normal. The blood morphology shows a slight eosinophilia. Blood chemistry is normal. The phthalein and CO₂ are normal. The serologicals are negative. The sugar tolerance is slightly depressed. A liver function test shows marked disturbance. She is 14 per cent underweight, the lung volume above prediction. Two basal rates show depression with low blood pressure and somewhat slow pulse rate. The X-ray shows a calcified pineal, evidence of previous pulmonary tuberculosis, calcification of cranial sutures and costal cartilages. The audiogram is normal while her cardiogram shows an axis deviation. The eyes show extra-ocular faults.

Diagnosis: Nonendocrine with definite hepatic dysfunction. The proper treatment seemed to control not only the tinnitus but also lessened very markedly the previous mental outbursts.

Case 3C.—A married woman, thirty-five years old, had a few months' period of frontal headaches followed by a loud tinnitus



in both ears. During this period she was extremely constipated. Then the tinnitus stopped in one ear, following inflation, but shortly afterward she had an attack of giddiness on arising one morning. These attacks became more violent, although up to this time they had been intermittent. The attacks then included active vertigo with nausea and vomiting; during one attack she fell sideways. They were mostly in the early morning but not entirely so, and during each attack the tinnitus became more intense as well as the deafness in the upper scale become more pronounced. Following these attacks there was marked fatigue and weakness, and the vomiting tasted of bile. The menstruation showed a slightly delayed onset, irregularity with increased interval, and a tendency to scanty flow. She lost seven pounds at the beginning of her giddiness.

Physical examination showed good development and some obesity, the heart is somewhat irregular, there is a possibility of enlargement, also a systolic murmur; the spine shows scoliosis and limited lateral motion. The urine volume is normal, elimination and balance good; albumin is reported, also a single hyaline cast. Nitrogen partition shows a somewhat low protein intake and a high residual fraction. Hemoglobin is slightly low; the blood is lymphoid in type. There is a high blood uric acid. Negative serologicals. A low normal phthalein. Normal CO₂. She was 20 per cent overweight with practically normal lung volume. The basal rate was -3 per cent with a subnormal temperature, slowed pulse rate and a normal blood pressure. The X-ray showed marked scoliosis, a negative skull and chest. The audiogram showed lowered aural acuity above the speech area, which, I may add, did not change with the physical improvement. An orthopedic examination defines a spinal condition and suggests an earlier poliomyelitis. A cardiogram confirmed the extra systoles and showed a normal axis. The eyes showed stiff pupils only. The liver showed a marked biliary dysfunction.

Diagnosis: Nonendocrine with marked hepatic dysfunction. In several months' time there was marked improvement in her general condition, including the local ear, nose and throat symptoms, although the hearing curve remained as at the first examination.

CONCLUSIONS.

1. One hundred twenty cases are reported of ear involvement associated with hepatic dysfunction.
2. The syndrome described includes a series of symptoms which in the frequency of observation are deafness, tinnitus, vertiginous symptoms, headaches, fatigue and nausea.
3. Characteristic audiometer findings seem to be a drop at 4096 d. v.
4. It is a syndrome that can be greatly relieved by proper care and treatment.
5. The syndrome is apparently primarily due to a long standing toxemia arising from a disarrangement of the liver chemistry.

In conclusion, the author wishes to express his sincerest indebtedness to Dr. Allan Winter Rowe.

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XXXIX.

MOTION PICTURE STUDIES OF THE LARYNX.*

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One of the most important recent advances in medical teaching and record is the utilization of the tremendous graphic possibilities of motion pictures to demonstrate not only disease in its various phases but medical and surgical methods as well. The teaching of laryngology has always been handicapped by the relative inaccessibility of the larynx for ordinary demonstration purposes. The student has usually been forced to visualize to the best of his ability the appearance of the larynx in various diseases from sketches often little more than diagrammatic. Disturbances in motility have been even more difficult to show. The important possibilities of actual photography of the larynx have been appreciated for many years, but the technical difficulties involved—especially those of securing adequate illumination—have proved a great obstacle. One is impressed, in reviewing the literature, by the limited interest taken in this important field; so that it seems fair to state that laryngology has not shared proportionately in the progress made with photography by other specialties.

The first successful photographs of the larynx were presented by Lennox Browne,¹ in 1883, before the British Medical Association. Browne, however, was frankly pessimistic about the possibilities of this work and stated bluntly that "to expect photographs from life of pathologic conditions was plainly unreasonable." In 1884, Thomas R. French² presented before the Section of Laryngology of the International Medical Congress at Copenhagen a remarkable series of photographs of normal and diseased larynges. His apparatus consisted of a small single lens camera

*Read before the American Laryngological Society, June 16, 1931, Atlantic City.

†From the University of Rochester School of Medicine and Dentistry, Rochester, N. Y.

with a throat mirror attached. The source of illumination was sunlight concentrated by means of a truncated metal cone with lenses and reflected into the subject's throat. These studies were presented before the American Laryngological Association in 1886 and again in 1888.³ In 1895, French⁴ improved his apparatus by substituting a powerful arc light as the source of illumination. No further advance was made until 1919, when Garel, after many years of work, perfected his apparatus for securing stereoscopic images of the larynx. In 1925, Clerf⁵ reported the successful use of the Garel camera together with a large series of interesting photographs. No popular use of the camera, however, resulted. Meanwhile numerous attempts had been made to apply cinematography to the larynx, but the need of relatively long exposures with poor illumination constantly produced failure. Finally, in 1920, Hegener and Panconceilli-Calzia of Hamburg, after a series of experiments begun seven years before, reported successful results. In 1930, Russell,⁸ using an apparatus which he calls the "Fonofaryngoskop," obtained small colored pictures of a normal larynx in motion.

About two years ago Dr. Charles A. Morrison of the Eastman Kodak Co. and the writer became interested in the possibilities of obtaining motion pictures of the vocal cords. With the history of laryngeal photography in mind, we considered it of first importance to design an apparatus which could readily be used by the laryngologist without expert knowledge of photographic technique. We felt that this could best be solved by employing a familiar instrument, the direct laryngoscope, with camera properly attached so that the entire procedure could be carried out as in performing direct laryngoscopy. The crux of the problem of obtaining full frame motion pictures at the rate of sixteen frames per second obviously lay in sufficiently illuminating the larynx without interfering with the limited channel by which light reached the camera lens. This difficulty was overcome by using a quartz rod by means of which a large quantity of cool light could be transmitted through the tube of the laryngoscope without encroaching seriously upon the field. The technical problems involved were most ingeniously solved by Dr. Morrison and an apparatus fulfilling the original requirements was produced.

Description of Apparatus.—Fig. 12 is a side view of the instrument. Fig. 13 is a bottom view, showing the plan of the optical system as is diagrammatically illustrated in Fig. 14. The unit consists of a model B Ciné-Kodak, attached to a metal plate, which also serves to hold the laryngoscope and illuminating system. A viewing system is fastened to the side of the camera.

An $f/3.5$, 50 mm. objective lens replaces the standard one of 25 mm. equivalent focal length. This is so placed that the object lies 19 mm. in front of the lip of the tube on the laryngoscope. A lens of larger relative aperture would reduce seriously the depth of focus. Illumination is provided by a 21 cp., 6-volt automobile headlight bulb, using a voltage 50 per cent greater than the rated value. Both filaments are used simultaneously. A condenser of high relative aperture consisting of three spectacle lenses, having a power of twenty-two diopters and so chosen to give the least spherical aberration, has a free aperture of 41 mm. and an equivalent focal length of 45 mm. This condenser images the filaments of the bulb at the end of the quartz rod, the end of which is ground to form a 45 degree prism. The prism, silvered on the hypotenuse, reflects the light along the 4 mm. quartz rod from the end of which the light is virtually sprayed over the photographic field. The center of interest lies somewhat off the axis away from the lip of the laryngoscope; therefore, the end surface of the rod is ground to form a 15 degree prism in order to center the light on the field. This method of illumination provides a cool light with an intensity of 400 to 600 foot candles on the larynx.

A par-focal viewing system is attached to the side of the camera and enables the operator to focus the instrument on the vocal cords and to observe the field while the camera is running. The entire system is conveniently formed by a combination of microscope optics or their equivalent. A 48 mm. objective is used, stepped down by a 3 mm. diaphragm. The erecting system is a 32 mm. objective and the eyepiece is a 5x ocular. The field is seen by the eye in the same position as it will appear on the screen. The mirror attached back of the objective lens of the finder and the 2 mm. prism mounted just ahead of it to serve to alter the direction of the optical axis for convenient placing of

the eyepiece. The small tube originally built into the laryngoscope to hold the pea-lamp, which served as an illuminant for visual use, is extended to the lip of the instrument to serve as an aspirator for the removal of excess mucus which may collect in the field.

In using the instrument at room temperature there is a possibility of moisture condensing on the camera objective. To prevent this the entire apparatus is warmed to about 37° C. just before passing it into the oral cavity. The heat from the lamp housing and contact with the throat structure will hold the temperature at the proper level to prevent condensation during the taking of the pictures. One winding of the camera motor usually suffices for the record of a patient.

Results.—Four fifty-foot films are shown to demonstrate the photographic possibilities of this apparatus. The first film shows the normal larynx. The vibrations of the cords and the complicated movements of the arytenoid cartilages are particularly well seen. The second series pictures the larynx of an adult with a complete left vocal cord palsy resulting from an enormous aneurysm which, in addition to destruction of the left recurrent nerve, had caused marked compression of the trachea. The third film shows an early carcinoma of the right vocal cord unassociated with any disturbances in motility. The fourth film shows a typical tuberculous larynx.

CONCLUSIONS.

1. An apparatus is presented which enables anyone familiar with the principles of direct laryngoscopy to secure excellent full screen motion pictures of the larynx at the rate of 16 frames per second. Certain subjects of course will prove difficult or impossible to photograph successfully.

2. By utilizing the quartz rod we have been able to secure adequate illumination without danger of burning the delicate mucous membrane. Faulty illumination has heretofore constituted the greatest obstacle to laryngeal photography.

3. Motion picture photography not only opens the way for tremendous progress in the teaching of laryngology, as well as the recording or presentation of interesting and unusual disease

conditions, but also contributes to a clearer understanding of laryngeal movements. It is well known that the rapidity of movements in fine muscles makes direct visual observation unsatisfactory.

4. We feel confident that with the perfection of apparatus inevitable from increasing use (especially decrease in the size and weight of the camera, as well as the perfection of color photography), an important but neglected chapter in laryngology will be reopened.

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LARYNGEAL PHOTOGRAPHS

Figs. 1-7 show various phases of the normal larynx in motion.

Figs. 8, 9, 10 show paralysis of the left vocal cord resulting from aortic aneurysm.

Fig 11 shows carcinoma of the right vocal cord unassociated with cord palsy.

NOTE: The clear cut character of the film itself is considerably sacrificed in making these reproductions.



Fig. 1.

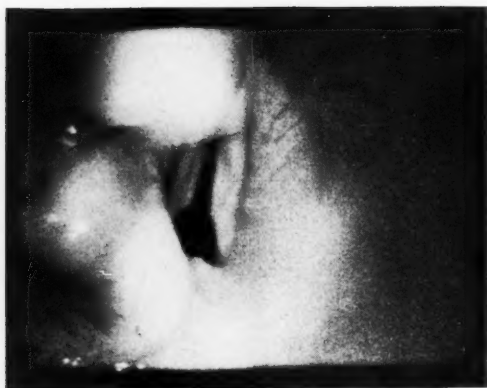


Fig. 2.



Fig. 3.



Fig. 4.

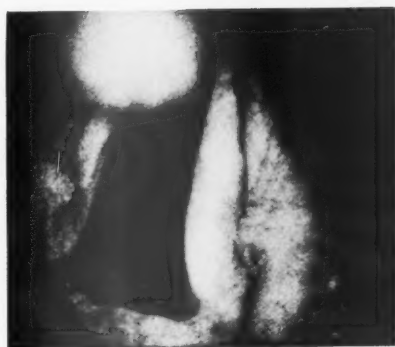


Fig. 5.



Fig. 6.



Fig. 7.



Fig. 8.



Fig. 9.



Fig. 10.



Fig. 11.

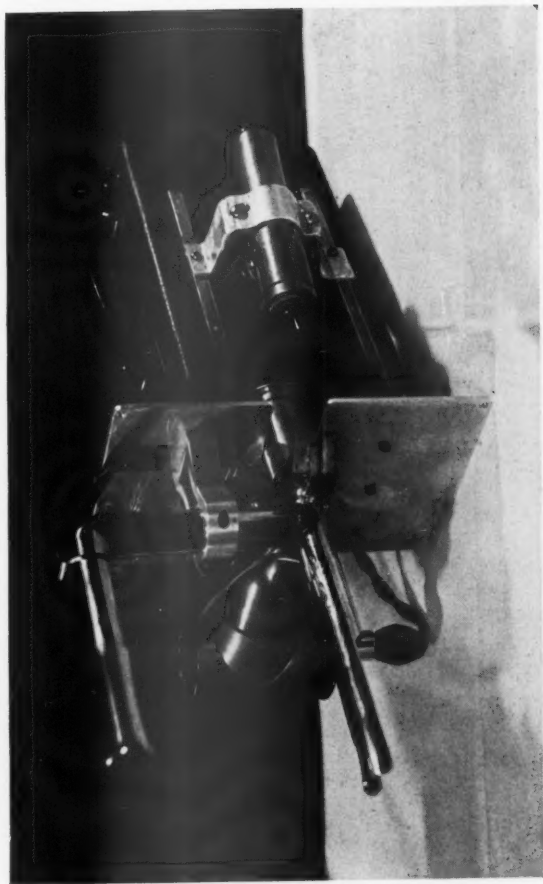


Fig. 12.

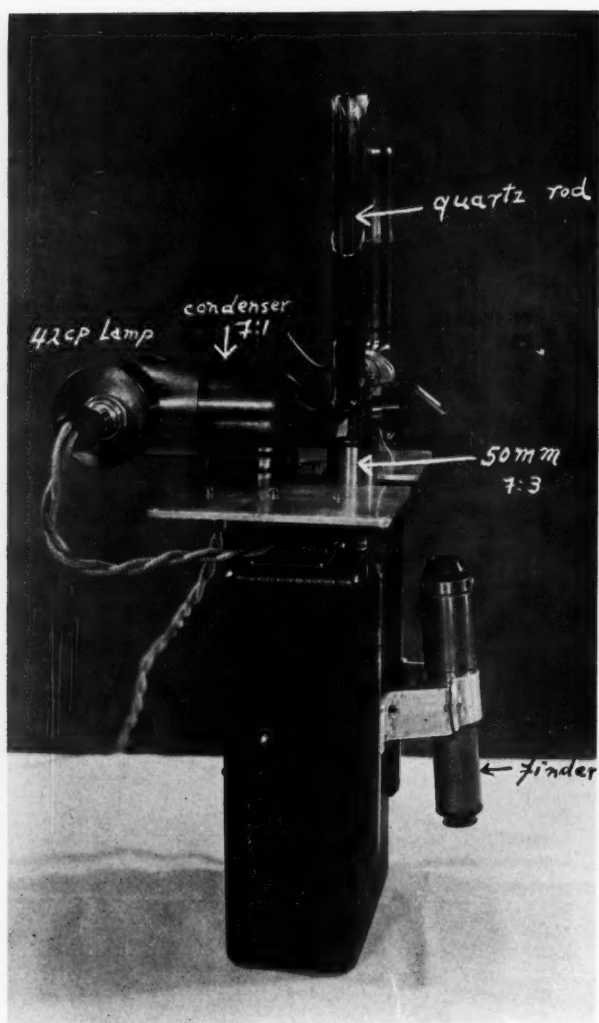


Fig. 13.

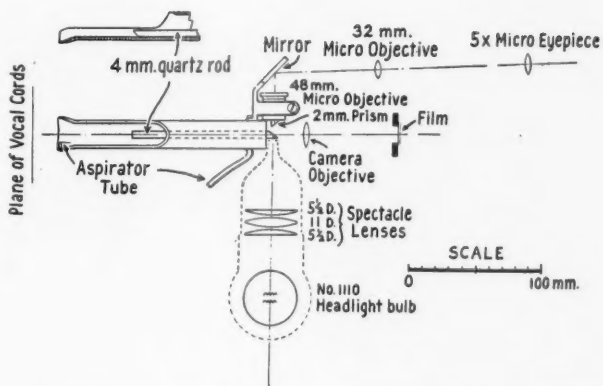


Fig. 14. Schematic diagram of the optical system of camera, lighting system, and finder, attached to laryngoscope.

XL.

BONE CONDUCTION AS AN ELEMENT OF ERROR
IN AUDIOMETRY.*

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PHILADELPHIA,

AND

JOEL JAY PRESSMAN, M. D.,

LOS ANGELES.

In testing a series of patients markedly deafened because of chronic suppurative middle ear disease, we became strongly of the opinion that certain audiometric curves obtained with the telephone receiver designed to transmit sound by air were, in some instances, records not of air conduction but of bone conduction. This suggested itself to us because the AC audiometric curves of many of these patients closely resembled one another, whereas, in fact, there existed extremely wide variations in ability to hear during the course of ordinary conversation. It was apparent that the air conduction of these individuals was not by any manner of means as similar as the audiometric studies would have led us to believe. If these similar so-called air conduction audiometer tracings obtained by use of the telephonic ear phones actually represented bone conduction, then the bone conduction curves of these individuals should be nearly alike, and the AC and BC audiometer tracings should closely resemble one another. This actually proved to be the case. There did exist a very marked similarity in the bone conduction curves (obtained with forks and the audiometer bone conduction apparatus), and the AC and

*Thesis (being Part II of the thesis work) submitted to the Faculty of Otolaryngology of the Graduate School of Medicine of the University of Pennsylvania in partial fulfillment of the requirements for the degree of Master of Medical Science (M.Sc. [Med.]) for graduate work in Otolaryngology.

†Presented before the American Laryngological, Rhinological and Otolological Society, Saint Louis, June 3rd-5th, 1931.

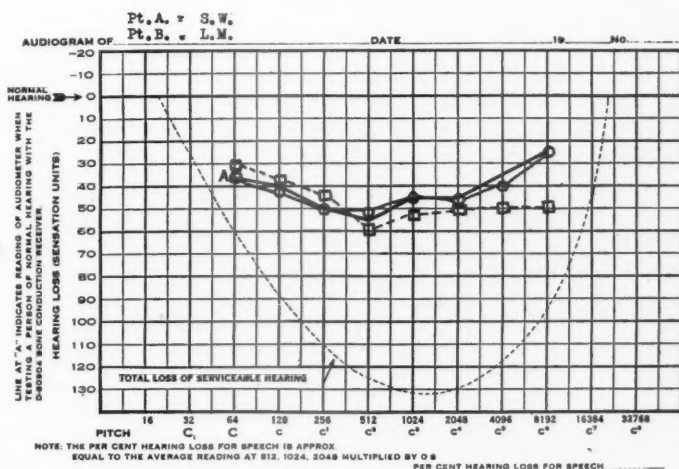


Fig. 1

Audiogram	AC Fork	BC Fork	Wh. Voice	Sp. Voice	Watch
Pt. A. □—□	12 sec	40 sec	not heard	12 in.	3 in.
Pt. B. ○—○	60 sec	45 sec	36 in.	96 in.	24 in.
Norm (Sil. Fork)	90 sec	40-45 sec	20 feet	?	96 in.

Fig. 1. Two patients demonstrating similar audiograms but with considerable variation in ability to hear forks and voice.

BC curves of the same ear almost exactly superimposed one upon the other.

An example of two ears with marked variation in ability to recognize spoken voice, tuning forks and the watch but with similar audiograms is given in Fig. 1. Fig. 2 demonstrates the similarity in the bone conduction of these two individuals, and by comparing Figs. 1 and 2 the similarity of the AC and BC curves may be recognized.

The purpose of this presentation is to prove the truth of the assumption that under certain conditions the audiometric tracing gives a false picture of air conduction, due to the fact that it is actually recording sound transmitted through bone. It is obvious that this phenomenon can be recognized only in cases where the bone conduction is greater than air conduction and the Rinne therefore negative; for otherwise the higher level of the air curve obscures any element of bone conduction that might be taking

less than the level of bone conduction, our method of testing for AC must be such that the bone conduction element does not superimpose itself to any greater degree than physiologically occurs during the course of ordinary conversational hearing or tuning fork tests. We believe when testing with the audiometer ear phone under the conditions described, the true proportion bone conduction plays in audition is greatly exaggerated. The resulting curve does not present a true picture of the ability of the individual to recognize sound reaching the cochlea by the route which we term "conduction by air," but presents in those cases in which bone conduction is the more sensitive mechanism, a curve representing the latter, which, being the greater of the two, completely obscures the air conduction curve, which we are seeking to determine.

Bearing in mind the contact that exists between the ear phone and auricle, it is not remarkable that an undue amount of bone conduction should occur. Sonnenschein² has pointed out that a fork placed over the tragus conducts not only by air, but by bone and cartilage as well, because of the attachment of the tragus to the skull, and such a contact occurs in an exaggerated form when using the telephone receiver. This authority, however, denies an undue element of bone conduction in audiometry³ on the ground that the sounds produced are transverse and not longitudinal vibrations. We do not believe that these theoretical conclusions are justifiable, and feel that the weight of experimental evidence tends to disprove them.

The observation that an undue element of bone conduction exists in this method of testing, has been recorded by previous observers. We came upon it independently, during the course of researches involving an entirely different problem, and were therefore not prejudiced by the weight of evidence in the literature, nor at the time of our experiments were we familiar with it. Fowler⁴ and Shambaugh^{5 6} have repeatedly stressed this point. For instance, observing that during the course of telephone conversation deafened persons, with increased bone conduction hear remarkably well with the receiver placed against the side of the head, and that persons with diminished bone conduction hear very poorly, Shambaugh⁶ concludes "We should expect therefore to

find that in testing with an electrical audiometer where a similar earpiece to that of the telephone is used for conducting the sound waves into the ear that bone conduction plays a not unimportant part."

These facts, however, have not become generally known, and since great importance is attached to audiometry, the instrument being more and more widely used, we consider it worth while to report our observations confirming the results of previous authors and recording additional experimental data bearing upon this point. It is not our purpose, nor are we able, to present data establishing, in a quantitative way, the exact factor of bone conduction which exists in testing with ear phones, but of necessity content ourselves with observations to prove that because of bone conduction a considerable element of error exists and is sufficiently great to be of practical importance. The following experiments each tend to prove that bone conduction takes place from the telephonic ear phone.

Experiment 1.—The validity of the following experiment may be questioned because of the views of certain authorities that the audiometric bone conduction apparatus is inaccurate, but in our experience, except for the very low and very high notes in which the excessive vibration gives rise to undue tactile sensation, the results obtained with this instrument compare accurately with those resulting from the use of forks.

The proper relationship between air and bone conduction was determined by the usual methods of testing with tuning forks. A standardized blow was struck, after the method of MacFarlan.⁷ Audiometric tracings using the telephone earpiece were then made and compared with audiometric tracings with the Western Electric bone conduction apparatus, No. D 80904.

Since only cases known to be Rinne negative were used, the bone conduction by fork was greater than that by air. It is expected, then, that when comparing air and bone audiometer curves that a similar relationship will exist and the bone curve be at a higher level than the air curve. But if the telephonic earpiece conducts by bone, then in these cases the air and bone curves should be equal.

In our experiments the latter condition has prevailed, and air conduction has in each instance, when tested audiometrically, been exactly the same or at least as great as bone conduction. This observation we are unable to explain except on the basis that bone conduction takes place when the ear phone is used.

Pohlman⁸ has recently reported similar observations upon the equality of audiometric air and bone curves in Rinne negative patients with normal bone conduction. He interprets this observation as being "direct evidence of the almost equal functional efficiency of the air sound transmission apparatus throughout the audible range." This conclusion may be correct, but, in our opinion, the experiments above quoted, and upon which the conclusion is based, are more apt to indicate that when the ear phone instrument is used bone conduction is taking place from the ear phone and that it, rather than air conduction, is being recorded on the audiogram. In this case, as in our experiments, the curve would of course equal that obtained with the usual bone conduction apparatus. This is the only logical conclusion that can be drawn, since we know from the fork tests that air conduction is actually diminished below the level of bone conduction. The increase in AC to reach the level of BC can only take place through the medium of bone conduction which we must therefore assume is taking place.

Fig. 3 presents actual cases illustrating this point.

In carrying out these experiments we are conscious of one error in technic. In testing AC with the fork, for purposes of comparison with BC, we failed to create a similar and constant damping factor by neglecting to intermittently dampen the fork against bone, as necessarily took place when BC was tested. Fowler¹ has stressed the importance of this technic and has demonstrated that failure to consider this added damping may result in an error of 10 to 30 sensation units. However, had this precaution been observed, the AC by fork would have been further diminished below the BC. Our error, therefore, in no way lessens the significance of these observations, but actually enhances their value, so far as this particular experiment is concerned.

Experiment 2.—Fowler,¹ Clark,⁹ and Pohlman and Kranz¹⁰ have demonstrated that conduction by bone takes place from any

point on the skull to either ear and this has been quantitatively measured. The loss in intensity during the passage of sound through bone from one mastoid to the opposite ear is not great.

	— 512 Tuning Fork —		— 512 Audiometer —	
	A.C.	B.C.	A.C. (Ear Phone) Sen. Unit	B.C. (No. D80904) Sen. Unit
Pt. A (R)	15	40	55	55
Pt. A (L)	12	35	60	60
Pt. C (L)	35	65	55	60
Pt. D (R)	25	58	65	65
Pt. E (L)	20	35	65	65
Pt. F (L)	20	40	50	50
Pt. G (R)	10	35	60	55
Pt. H (L)	25	45	65	65
Pt. I (L)	20	40	60	60
Pt. J (L)	12	30	40	45
Pt. K (R)	15	40	50	50

NOTE: Patients C and D were tested with a fork of longer period of vibration than the others. All B.C. levels except J are normal.

Fig. III.

A group of rinne negative patients. Note that with tuning forks air conduction is much less than bone conduction. Tests with the air and bone conducting apparatus, however, result in equality of A.C. and B.C. audiometer readings. This is interpreted as indicating that the audiometer "air conducting" ear phone is recording bone conduction. The discrepancy does not lie in the B.C. audiometer tests, because these, being normal, agree with the findings by fork tests.

In point of fact, Sonnenschein¹² recalls to mind the theory of "diagonal resonance" or the "crossed-preception" theory, which maintains that a fork placed anywhere on the skull except the vertex is best heard in the opposite ear, and that closing the meatus causes an increase in bone conduction, even though the fork be placed on the opposite mastoid.

We have utilized this theory of "crossed-preception" in the following experiment designed to illustrate that by increasing the bone conduction in the opposite or normal ear, the level of hearing in the diseased ear is, when tested with the audiometer ear phone, correspondingly increased. Such a finding must be interpreted as indicating that at least the second curve obtained

with the ear phone represents not air conduction but bone conduction to the opposite side, despite the fact that it is ordinarily considered as testing transmission by air. This must be true, since the only change to account for our rise in level of hearing in the second test is an increase in bone conduction in the opposite ear to which the sound is transmitted across or through the skull.

The experiment was carried out as follows: Air and bone conduction for both ears was determined with tuning forks and an audiometric curve with the ear phone obtained for the Rinne negative ear. The opposite or normal external auditory canal was then occluded by a cotton plug saturated with tap water. Tuning fork tests were repeated on the packed or normal ear, and in each instance the BC was found to be increased and the AC diminished. A second audiometer reading was then carried out on the diseased ear. In every case it was found that a very appreciable rise occurred in the audiometer curve when the opposite canal was occluded, which could only have resulted, as has already been pointed out, if conduction from the ear phone was taking place through bone to the ear on the opposite side. In addition, in some instances the audiometer bone conduction apparatus was used to test the diseased ear before and after packing the opposite canal. The increased hearing in each instance noted with the so-called air-conducting ear phone was closely paralleled by a rise in the curves obtained with the bone conducting apparatus. When the air and bone audiometer curves superimposed before packing the opposite ear (as described in experiment one), such superimposition inevitably occurred after the opposite ear was packed, but at a higher level. Packing the opposite ear obviously does not affect air conduction in the tested ear, but it does affect bone conduction. Since the ear phone and bone conducting apparatus curves were similarly affected and to the same degree, we are forced to conclude that the manner of their transmitting sound must be similar and that bone conduction curves have resulted from testing with the ear phone. It is also apparent that the audiometric curve of hearing depends not only upon conditions of bone conduction in the tested ear but in the opposite ear as well. Were any other assumption correct, there would have been

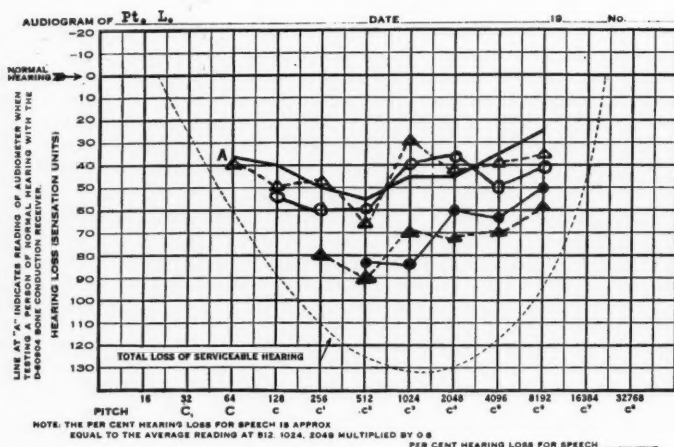


Fig. 4A.

A.C. Audiom. Curve	Left Ear Without Packs	Left Ear With Pack In Right	Normal
B.C.	—	—	
A.C. 512 Fork	22	15	100
B.C. 512 Fork (a.o. 984)	15	45	50-55

Note: Pack in right ear increased B.C. in the packed ear from 55 to 75 seconds.

Fig. 4A. Demonstrating the elevation in air and bone conduction audiometer curves from increasing bone conduction in opposite ear. Note that no increase in air conduction occurs when testing with forks. This is interpreted as indicating that the audiometer ear phone records bone conduction.

no rise in the ear phone curve to correspond with the elevation in bone conduction in the opposite ear. Such a rise did not occur in testing AC with forks which give a true measure of air conduction insofar as it can be considered an entity.

Tracings of two patients demonstrating these points are given in Figs. 4A and 4B.

We have argued that the improvement in hearing upon packing the opposite canal indicates that at least our second curve represents bone conduction taking place through the ear phone. Note that this improvement is almost entirely limited to the frequencies below 1024, and above that level no rise in the level of hearing occurs. This is in keeping with observations by Pohlman and

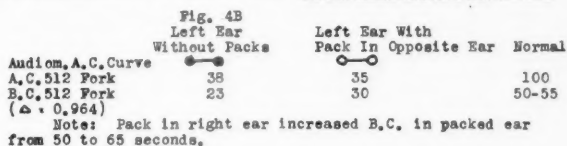
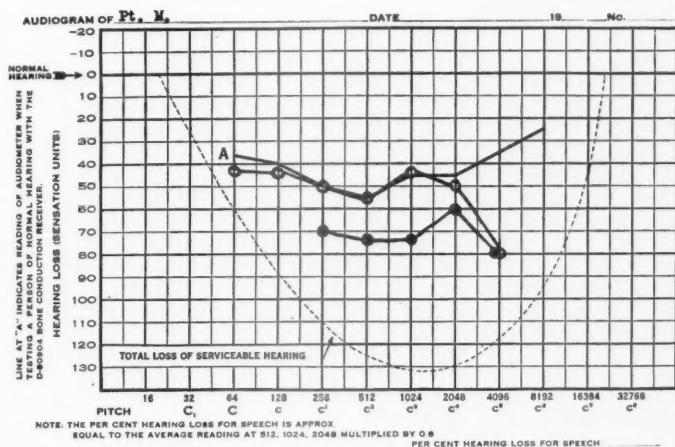


Fig. 4B. Demonstrating the same phenomenon as Fig. 4A.

Kranz,¹⁰ indicating that when bone conduction is increased by artificially producing an obstruction in the external auditory canal the improvement is almost entirely limited to auditory field below 1024 D. V. We believe this observation of Pohlman and Kranz is especially important since it indicates that certain types of obstructive as well as nerve deafness may give hearing curves in which the maximum loss is in the higher range.

It may be logically asked why in conducting this particular experiment the opposite ear was occluded instead of the one being tested. Downey¹¹ has pointed out that unless a completely mobile ossicular chain is present, assuming the labyrinth to be normal, bone conduction cannot be appreciably increased by occluding the canal. Since our experiments were carried out upon patients with chronic inflammatory changes in the middle ear being tested, mobility of the ossicles was considerably impaired, and an elevation in bone conduction could not be artificially pro-

duced by packing. For this reason the opposite ear was packed, with the expectation that the sound would be transmitted by bone throughout the skull, and any rise in the level of bone conduction in either ear be recorded, regardless of the ear being tested.^{1 9 10}

Experiment 3.—In the presence of a dead labyrinth all hearing in the affected ear is lost, since the end organ has been destroyed. In testing such an individual with a dead labyrinth on the left and a normal ear on the right, we were able to demonstrate by repeated tests with the telephonic ear phone that the patient was able to perceive sound at a relatively low level of intensity. All question of guesswork or faulty observation was eliminated by repeating the tests several times on different days with almost exactly the same results on each occasion. The patient volunteered the information that he was hearing the sound in the normal ear, even though the diseased side was being tested. It is, we feel, reasonable to assume that the hearing recorded took place by virtue of bone transmission across the skull to the opposite side, and is in itself proof that the ear phone gives rise to a high degree of bone conduction. The question may be raised whether or not this perception of sound may not have been due to transmission by air around the head to the opposite ear. If this were true, then when testing the diseased ear a pack in the normal or opposite ear should diminish the perception of sound, since the AC in the opposite ear is diminished; but if transmission takes place through bone, then the acuity of hearing should be increased, since the occlusion of the canal increases the bone conduction. In point of fact, packing the normal or opposite ear markedly increased the ability of the patient to hear sound transmitted by the ear phone. It must follow then that the transmission of the sound took place not around the head by air, but through the skull by bone. Tuning fork tests by bone conduction with a fork placed on the mastoid of the diseased ear resulted similarly, the length of perception being increased by packing the normal canal.

There is no question in our mind that this patient had a dead labyrinth, both static and acoustic. He was admitted to Temple University Hospital complaining of a discharging ear of many years' duration and a partial facial paralysis. Several months

prior to admission he had suffered a typical attack of labyrinthitis. Fistula test was negative. The Bárány revealed complete loss of function of the vertical and horizontal canals on the affected side. He was unable to hear the shouting voice, any tuning fork, the Galton whistle or a variety of noise making instruments. At operation, the horizontal semicircular canal was found to be necrotic, and its lumen exposed, through which a probe could be passed. On the basis of these findings we feel free to assume that this affected ear is incapable of hearing and that when tested with the audiometer ear phone should result in total or nearly total loss of hearing unless bone transmission is taking place, the sound thus becoming audible to the opposite ear. The patient's audiometer curve demonstrated an average loss in the speaking range of 70 sensation units, or 56 per cent. When the opposite ear was packed there was a gain in hearing to 47 units, or a loss of only 37.6 per cent. Removal of the ear phone one inch from the ear resulted in total cessation of all hearing. Bone conduction audiometer tests gave almost exactly parallel results, a rise taking place after packing the opposite ear.

The results of tests on this patient are recorded graphically in Fig. 5.

A second patient, W. J. M., with a nonfunctioning acoustic labyrinth was tested, and for this privilege we are indebted to Drs. George M. Coates and Harry Goodspeed. This was a young man with a history of bilateral suppurative otitis media of long duration. A right radical mastoidectomy had previously been performed. Two months later he developed intracranial symptoms, and exploration of the right mastoid cavity revealed necrosis of the first turn of the cochlea (the promontory) with a fistula into the labyrinth. It was thought best to surgically exenterate the cochlea, and this was done. Recovery proved uneventful. Testing took place about ten weeks after the labyrinthine operation. Obviously this ear is incapable of hearing. Audiometric tests, however, reveal an average loss of only about 63 sensation units, or 50 per cent. (Fig. 6.)

This residual hearing could have taken place only by transmission through bone to the opposite ear, for transmission around

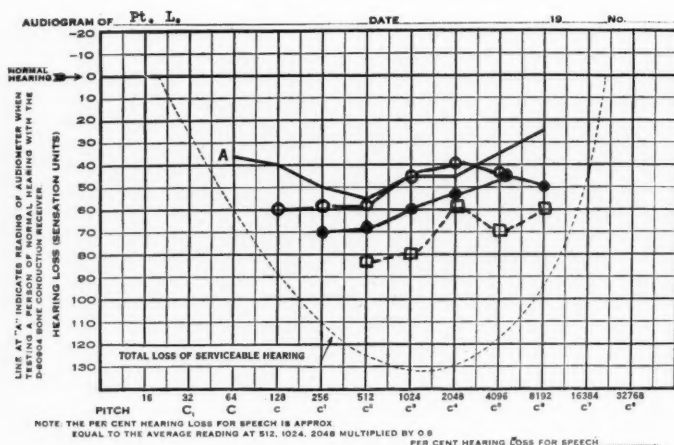


Fig. 5

- = Audiogram Left Ear With Pack in Right (Opposite Canal)
 ●—● = " " " Without Pack in " "
 □—□ = " " " Ear Phone One Inch From Auricle.
 Pack in Right (Opposite) Canal

Fig. 5. Audiograms from ear with non-functioning (necrosed) labyrinth. The opposite ear is normal. Tracing recorded is believed due to bone conduction from the ear phone through the skull to the opposite ear, because when B.C. of the opposite ear is increased and A.C. diminished by packing the canal, the audiogram of the non-functioning (tested) ear is elevated. Patient deaf (left) to forks, shout, etc.

the skull by air was ruled out by packing the opposite canal, resulting in a loss of air conduction in the opposite or packed ear but no diminution in hearing when the nonfunctioning ear was tested with the audiometer.

In this case no rise in the level of hearing in the operated ear by audiometer tests occurred when the opposite ear was packed, because previous suppuration in the opposite ear made it impossible to elevate the bone conduction, as previously described when quoting Downey.²⁰

Similar observations and conclusions have been previously reported by Shambaugh and Holderman,⁶ who were able to present a large series of such cases in which relatively high audiometer curves were obtained from ears in which the cochlea had been totally destroyed. This was interpreted as being due to bone con-

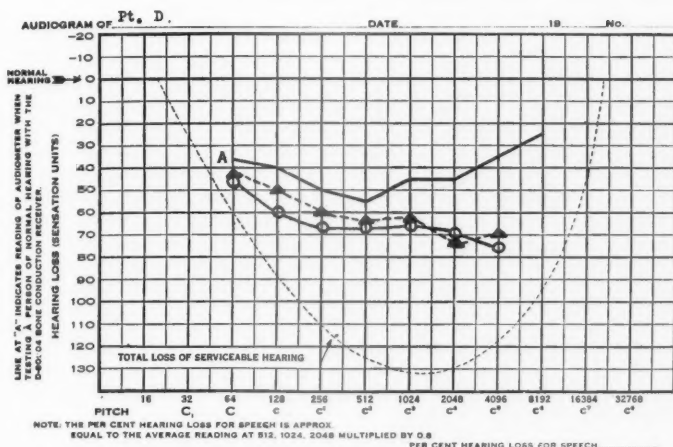


Fig. 6

○—○ = "Air Conduction" Audiogram
 ▲—▲ = Bone Conduction Audiogram

Fig. 6. Demonstrating same phenomenon as Fig. 5. A relatively high audiometric tracing in a patient with a non-functioning labyrinth. The cochlea was eviscerated surgically by Dr. G. M. Coates. When the opposite ear is packed, the curve does not drop, ruling out transmission by air around the head.

duction to the opposite ear; when the ear phone was barely removed from the auricle all hearing ceased at once. Shambaugh's cases demonstrating this point are far more convincing than anything we are able to present. However, we have been able to add evidence to prove that these sounds do not reach the opposite ear by air conduction around the skull.

Fowler, too, is the same opinion. We quote from his writings:⁴ In speaking of the audiometer ear phone, he says: "The curve of hearing of a totally deaf ear may seem an anomaly. It really represents the hearing of the good ear as determined with the receiver over the ear." We have used no headpiece, and our experiment in increasing perception by packing the opposite canal leads us to believe that of these factors mentioned by Fowler, by far the most important is transmission through the skull.

Experiment 4.—We have already indicated that Shambaugh has observed⁶ that testing an ear of which the labyrinth had been destroyed, a certain amount of hearing persisted, which immediately ceased when the ear phone was lifted from the ear. This cessation of hearing when the ear phone is barely removed from the auricle is strong evidence to prove that the sound had actually passed through bone to the opposite ear and that the curve of hearing obtained with the ear phone against the auricle was one of bone conduction and not air.

We are able to report a similar series of experiments upon persons with a high degree of deafness, whose conduction by air was less than the bone conduction level of one ear or the other.

We first determined the actual hearing level by air and bone with tuning forks, and then made audiometric tracings with the ear phone against the auricle. The audiometer tests were then repeated by lifting the phone from the auricle and removing it a distance of about one inch so as to eliminate any possibility of tissue conduction. A second tracing was then made. In each case tested the Rinne was negative, so that when testing with ear phones, if bone conduction is recorded when the phone is against the auricle, then tests made with the phone removed from the auricle should give a lower reading, since this latter test would obviously be one of air conduction. On the other hand, if the ear phone transmits chiefly by air when held against the auricle, there should be no great change in removing it a distance of one inch.

Without exception, there resulted a marked drop in acuity of hearing when the phone was removed from the auricle. Note that with the phone against the ear the curve is nearly the same as the bone conduction audiometer curve. In some instances the loss upon barely removing the phone from the ear was as much as 40 sensation units for certain tones. Curves to illustrate this experiment are given in Fig. 7A and 7B. Only two examples are given but the phenomenon has been observed in nearly every patient referred to in this report.

We have found that by packing the opposite external auditory canal, as described in the previous experiment, the difference in

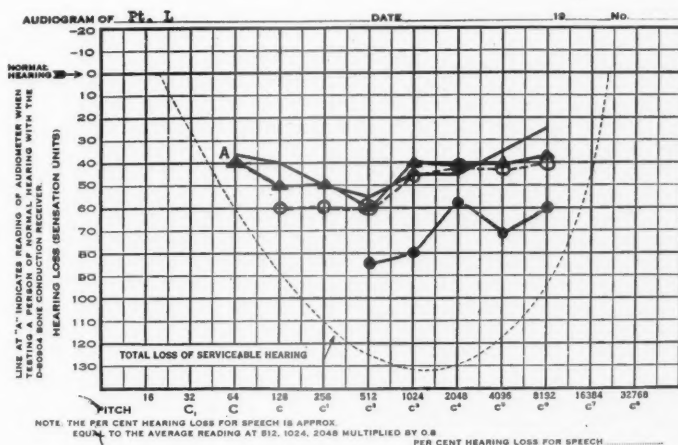


Fig. 7A

(Pack in opposite external auditory canal to prevent dissemination of sound around head to opposite ear).

Bone Conduction (Apparatus #D80904)

Air Conduction with Ear Phone Against Auricle

		A.C.	B.C.
512 Fork	Patient	15	45
0.964	Normal	100	55

Fig. 7A. Demonstrating the drop in audiometer curve when the ear phone is removed from the auricle, thus removing the element of B.C. taking place from the ear phone. Note that with phone against ear A.C. and B.C. are alike.

hearing level with phone against and barely removed from the auricle could be increased. Some of the experiments were conducted with this modification. It in no way changes the significance of the results, since we are not interested in actual levels of hearing but solely in comparative levels.

Such results justify only one conclusion. The ear phone, when placed against the auricle of these Rinne negative ears, gives a bone conduction curve, instead of one of air conduction.

We have one patient (Miss T. Y.), about whom more detail is given in the next experiment, who when tested with ear phones attached to the phonographic audiometer was able to hear and record the spoken numbers so accurately that her loss of hearing

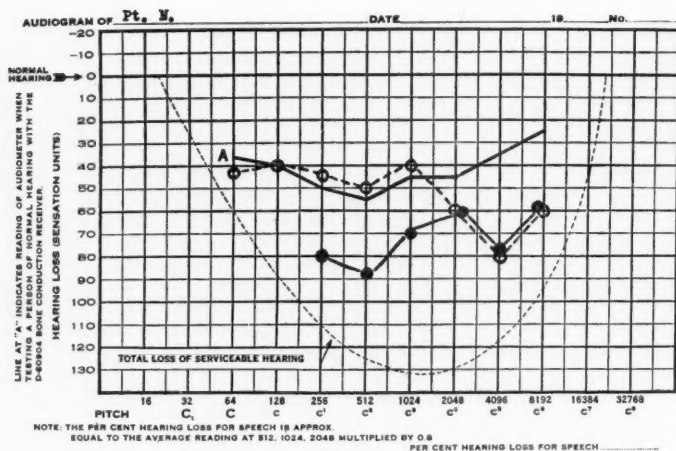


Fig. 7B

○-○	=	Ear Phone against auricle
●-●	=	Ear phone removed one inch from auricle (Pack in opposite external auditory canal)
		A.C. B.C.
		Deafened Ear 40 35
512 Fork	Opposite Ear	100 55
Δ-Δ-904	Normal Ear	100 55

Fig. 7B. Demonstrating same phenomenon as Fig. 7A. There is a marked drop in audiometer curve when ear phone is removed one inch from auricle. The difference in the two curves presumably represents the amount of B.C. superimposed on A.C. when phone is against ear.

by this method of testing was only 6 per cent. When the ear phone was removed one inch from the auricle, she was unable to recognize a single spoken number. There can be no question that bone conduction taking place from the ear phone against the auricle enabled the patient to recognize the numbers, and a 6 per cent loss is without doubt only a small fraction of her hearing loss by air conduction.

Experiment 5.—This experiment is cited as an interesting observation bearing out contentions which have already been described, but since it represents only one case its value is accordingly limited.

Miss T. Y., a young, very intelligent school teacher, sister of a physician, had no subjective loss of hearing until June, 1929.

a year prior to our examination. This loss had markedly increased during the past six months, becoming so profound that it was necessary for her to resort to lip reading, at which she rapidly became adept. She was forced to discontinue teaching because of her disability. During the summer vacation of 1930 she tried various mechanical appliances, and in her particular case the Graybar apparatus proved most effective. With this instrument she was able to hear conversational voice readily, and with its aid was able to resume teaching, without marked handicap.

Her clinical picture, while not typical, closely resembled otosclerosis. A definite diagnosis could not be made, but this fact does not decrease the relative value of hearing tests made upon her.

There is absolutely no question that this patient enjoyed a very marked improvement in conversational hearing from the use of the Graybar. Her audiometric curves, charted in Fig. 8, reveal the interesting and puzzling observation that despite marked actual improvement in conversational hearing with the Graybar, the level of hearing as determined with the audiometer is considerably lower with the Graybar than without it. We are not at all certain of the significance of such an observation. It would seem that if the original audiometer curve without the use of any artificial aid to hearing represented air conduction there should be a marked rise in the level of the hearing curve when testing takes place with the artificial aid to hearing in situ, since this occurred clinically. Such a rise did not take place. These findings can logically be explained by assuming that the curve obtained by testing with the audiometer, without artificial aid to hearing, represented bone conduction, and that the true level of hearing by air was considerably less than our curve led us to believe. This is solely a matter of conjecture and the observations are not presented as proof. In keeping with the results of the other experiments described such an observation may be of significance.

There remains to point out how and under what circumstances the bone conducting element in testing with the telephone ear-piece may lead to clinical error. Such error can occur only when the air conduction of the ear being tested is less than the bone

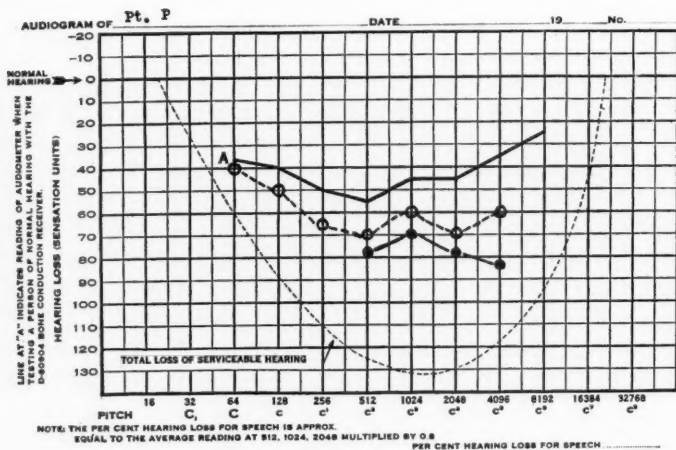


Fig. 8

○—○. Audio, curve without artificial aid to hearing
 ●—●. Audio, curve with ear phone against receiver of Graybar

Fig. 8. Despite lower audiometer curve with Graybar this patient with artificial aid to hearing in situ was able to hear ordinary conversational voice from any point in a large classroom, and is able to teach school. Without Graybar, has difficulty in hearing speaking voice at one foot. B.C. by fork varies from 35 to 50 (normal = 50 to 55). Both ears are alike.

conduction of either one ear or the other or both. In all other cases the air transmission mechanism, being more sensitive than bone transmission, can conduct sounds of a lower intensity than the latter. If sound passes through the ear phone at such a diminished intensity that it is perceptible by air conduction but not by bone, the resulting record is therefore probably a true picture of air conduction. On the other hand, if due to pathologic changes, bone conduction becomes more sensitive than air conduction, and the result is that sound passing through the ear phone is heard at a lower intensity through bone transmission than air, and this former mechanism then furnishes the route by which the presence of a gradually increasing intensity of sound is first recognized. The result of audiometry then becomes a curve of bone conduction rather than air. This result occurs because of the approximation of the ear phone to the side of the head.

Let us presume that a patient presents himself for hearing tests. The Rinne is negative. An audiometric tracing is taken, using the ear phones. This curve in no way indicates to us the true level of air conduction which we are seeking, but rather denotes the bone conduction. Air conduction may actually be anywhere between the resulting curve and one denoting total loss of hearing. At a subsequent examination the same curve may be obtained. This does not indicate the progress or lack of progress of the patient's hearing. It may have increased or diminished as much as 70 or 80 sensation units, for just so long as the level of hearing by air remains less than that by bone, the air conduction audiometer curve will remain stationary, closely approximating the bone conduction level. This is true, regardless of any elevation or diminution in ability to hear by air that might have occurred. As a result of this method of testing then, we are misled clinically, imagining the hearing to have remained stationary, whereas marked changes may have occurred.

An excellent example of clinical error that may occur in audiometric tests is well illustrated in the curves of patients with dead labyrinths. Here we can be sure that no hearing remains and yet an examiner not familiar with the past history of the case and limiting himself to tests with the audiometer would report a loss of hearing of only 50 per cent, whereas actually the loss of hearing is complete, at least in so far as air conduction is concerned. The error, of course, is due to the interpolation of the bone conduction element, and the transmission of sound through the skull to the opposite or normal ear.

A third source of error results in those cases where both ears are involved in a suppurative process. We have demonstrated experimentally that an elevation in the level of hearing, as determined by audiometry can occur in cases under consideration when bone conduction is increased in the opposite ear. Let us suppose that a certain level of hearing exists in a tested ear in which the AC is less than the BC of the opposite ear. At a subsequent test an elevation in the level of audiometric curve of the tested ear is observed. This is ordinarily considered as representing improvement in the hearing of the tested ear. However, it may

actually be due, not to improvement in hearing in the tested ear but to further increase in conductive deafness and a prolongation of bone conduction in the opposite ear. In this case, that which we have interpreted as improvement in hearing in one ear is actually and in fact no improvement at all, but simply a manifestation of further pathologic changes in the opposite ear as a result of which bone conduction in the latter has been prolonged. This has been proven in experiment No. 2. The converse is likewise true. A drop in the audiometric curve in the tested ear may not indicate further loss of hearing but rather an improvement in the conductive deafness and a resultant diminution in the bone conduction of the opposite ear.

We have on occasions noted that in unilateral nerve deafness the audiometer curve suggested deafness of the conductive variety, in that the high notes were heard as well as the low. This was not true of other forms of testing. The audiometer curve in these cases is misleading in that it gives erroneous data not only concerning the actual degree of loss of hearing but of the type of deafness present. This is due to recognition of the higher notes through bone conduction to the opposite ear.

These examples will serve to illustrate how the factor of bone conduction, taking place from the ear phone, may in actual practice result in audiometric curves which do not represent true hearing levels. There are many situations other than those cited in which the audiometer as a method for testing hearing gives grossly inaccurate results, failing to evidence progressive changes in ability to hear by air transmission and recording changes when none have occurred in the ear being tested. This is true, as we have stressed, only when air conduction is less than the bone conduction in at least one ear. In all other instances we believe that the audiometer is by far the most reliable, exact and practical method available for clinically testing the functional ability of the auditory mechanism. Under the circumstances we have described, however, the audiometer with its present type of ear phone is greatly inaccurate. In all cases where the air conduction of one ear is less than bone conduction of either ear this instrument should be discarded in favor of carefully conducted tuning fork tests.

The solution to the problem lies in finding a suitable earpiece from which an undue amount of bone conduction will not occur. This is by no means easily accomplished. We have tried a number of modifications of the present ear phone. Rubber sponge pads placed between the auricle and the ear phone resulted in the creation of a resonating chamber and proved to be entirely unsatisfactory. The problem is as yet unsolved clinically, but its solution must be accomplished before we as clinicians can accept this instrument of precision as a substitute for the intelligent use of the standardized tuning fork, which, in our opinion, still remains the most accurate method for testing auditory function.

SUMMARY.

1. Rinne negative individuals with marked differences in ability to hear conversational voice and tuning forks, presented similar audiometer curves. Because of the fact that the BC of these individuals was nearly alike (normal) and the AC audiometer curves were very similar to the BC audiometer curves it was thought that discrepancy might be due to bone conduction taking place through the ear phone.

2. Experiments were conducted to determine whether or not bone conduction actually took place from the telephonic earpiece. These experiments consisted of—

(A) Demonstration of a series of cases in which bone conduction by fork was normal and considerably better than air conduction, which was much reduced. The air and bone audiometer curves were, however, nearly similar. This was interpreted as being due to the fact that the ear phone gave rise to bone conduction recording this curve rather than air.

(B) The observation that by increasing bone conduction in the opposite or normal ear, by packing the canal, there resulted a rise in the audiometer curve of the tested ear, corresponding to the increase in bone conduction on the opposite side. Such a rise could only take place if the ear phone were recording bone conduction.

(C) The demonstration that a considerable degree of hearing by audiometer tests remained in individuals with destroyed labyrinths. This level of hearing could be increased by prolonging

the bone conduction of the opposite ear by packs in the external acoustic meatus. This was considered further proof that bone conduction takes place from the ear phone and that the residual hearing, as determined by audiometer in these deaf individuals, was actually a bone conduction curve resulting from transmission of sound through the skull to the opposite ear.

(D) The recording of observations that removal of the ear phone one inch from the auricle resulted in a marked diminution in the level of hearing, in certain cases amounting to total cessation.

(E) One case is outlined demonstrating a very marked improvement in hearing for conversational voice, but actually a lower curve by audiometer when an artificial aid to hearing is in situ. This is not given as proof but suggests that the audiometer curve obtained without the artificial aid to hearing may be due to bone conduction.

CONCLUSIONS.

(1) In Rinne negative ears, or in Rinne positive ears in which the AC is less than BC on the opposite side, the audiometer curve obtained with ear phones represents bone conduction and not air.

(2) This factor of bone conduction in the above mentioned type of case is sufficiently marked to give results which clinically are inaccurate and misleading.

(3) The audiometer, while most satisfactory in the majority of cases, is less so than tuning forks when air conduction is diminished below the bone conduction of one ear or the other.

1915 SPRUCE STREET.

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XLI.

A SURVEY OF FACT AND THEORY IN THE FIELD
OF OLFACTION.*

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WICHITA.

"I sing of smells, scents, perfumes, odors, whiffs and niffs, of aromas, bouquets and fragrances; and also, though temperately and restrainedly, I promise you of effluvia, reeks, foetors, stenchs and stinks."¹—McKenzie.

Scientific medicine in general and rhinology in particular have neglected the study of olfaction; in fact, it may, as Hendricks has pointed out, be called the Cinderella of our organs of sense. There are a number of reasons for this. To begin with, it is not one of man's directive senses, and the loss of it is no very serious handicap in the ordinary business of life. It is indeed one of the primitive senses of animal life. Man has developed his senses of sight and hearing, while his sense of smell has remained primitive.

On the other hand, investigation of the function itself presents almost insurmountable difficulties, and does not lend itself to measurement by the ordinary physical standards. In order to be able properly to investigate its function, it would be essential to be well versed in biology, physiology, chemistry, botany, psychology, etc. Indeed, the complexity of the chemical and physical factors involved in the process of smelling is as bewildering as the complexity of the reactions evoked. Finally, one of the most difficult things in relation to the investigation of smell lies in the lack of individual vocabulary pertaining to olfaction. No other sense has suffered from such a lack of verbal phrases covering the subject. It is therefore not surprising that the scientific investigation of osmics has been left, for the most part, to a few and

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that this work has been carried out during recent times. (Halladay.)

Henning,² who must be credited with the greatest amount of research on this subject, begins the preface of his book, "Der Geruch," with this dramatic statement: "Many of the sciences must bear witness to the assertion that in the beginning there was smell." When we remember that far back in the history of life, among the reptiles, the cerebral cortex appears as little more than an annex to the sense of smell, we must agree with Henning that we smell before we think. A number of investigators have found that the newborn child finds its mother's breast, not with its eyes, but by its sense of smell. An observation which strengthens this finding has been made by cattlemen from the Far Southwest. It has been found that calves cannot find their mothers after the cows have been dipped to destroy animal ticks, but are able to do so after the odor of the disinfectant has disappeared.

In man smell is not wholly concerned with the reactions to foodstuffs, sex, etc. It is no longer necessary to rely on one's sense of smell to detect an enemy or a mate, as is the case with animals. But the reactions initiated by odors are still provoked by the olfactory environment and may be either pleasant or unpleasant, friendly or inimical. The objection to bad odors preceded many of the scientific discoveries which in turn removed the unhygienic factors which produced these odors and also has succeeded in protecting us from many of our infectious diseases. In fact, the degree of advancement of a civilization, according to our Western ideas, may be measured roughly by the absence of objectional odors.

We may group mental reactions to smell stimuli as direct or indirect. The direct reactions are chiefly the perception of the quality and quantity of smell and the effect immediately produced thereby. Indirect reactions are the associations without affective tone subsequently evoked.

We are insensible to most of the smells that surround us, yet we are influenced by them more than we realize; for though the actual sensory impression of a smell is vague and difficult

to describe or recall to memory, it evokes a strong feeling tone. Sights and sounds are full of instant meaning to us; they belong to our directive mechanism and set us thinking. Smells, on the other hand, set us feeling.

Before proceeding with the subject matter proper of my paper, I wish to stress the fact that we really live in a world of smells. Few things are entirely odorless. We may easily cultivate an appreciation for the scents with which we come in daily contact and which for most of us are now nonexistent. McIndoo,³ says: "It was a custom with the Arabs, in their days of glory, to plant scented gardens, wonderfully devised, so that he who walked through them or whiled away an hour in them might delight in a cultured odor. They were so arranged that at the entrance the olfactory sense was struck by a strong smell, not necessarily of a pleasant nature. From this the path would lead gradually through less coarse fragrance to those more delicate, until at the end there would be reached an odor of exquisite quality which only the cultured nose could appreciate." The sense of sight and hearing are usually coupled, as are the senses of smell and taste. The latter two are intimately associated in a psychological sense. In fact, so much is this the case that in everyday life we are constantly attributing to taste the sensations which really belong to smell. They are also related biologically; both of them, though in different ways, stand guard over the great function of nutrition. If these statements are true and if smell as well as taste is a chemical sense, where then lies the difference? The answer is: most substances that we smell do not taste (for example, onions). With the nose closed, onions and apples cannot be differentiated by the sense of taste. Substances that we taste must be soluble in liquids, especially water; those that we smell must first be vaporized. One of the most important differences is a quantitative one. We taste only relatively strong solutions; we smell very dilute ones. This fact can best be demonstrated by substances that we can both taste and smell. As a consequence of the qualitative difference between taste and smell these two senses are used in a very unlike way. In taste the stimulating material is in the mouth and we locate it there. Again, in smell the stimulating material is likewise in the cavity harboring the sense organ, but we

do not think of it as there. We project it into the exterior, to the object from which the odorous particles came. In this respect smell is like sight. Finally, there are only four taste qualities—salt, sweet, sour, bitter, and possibly two others, alkaline and metallic—whereas, there is no known limit to the number of odors which can be appreciated by the sense of smell.

OLFACTION IN SOME OF THE LOWER FORMS OF ANIMAL LIFE.

It has been stated that the sense of smell is of vital importance in the lives of most of the members of the animal kingdom, and that it is primarily connected with the search for food. It also plays a large part in the choice of mates and in the detection of enemies and friends.⁴ Because the receptors of smell are distant receptors, the animals are brought into relationship with a remote environment, and are thus able to seek, avoid or recognize the distant body by its odor. The reactions of an animal to an odorous body are primarily one of attraction or repulsion. It follows then that smell determines the movement of animals to a large extent. The animal probably experiences a sense of awareness associated with these movements corresponding to our idea of an emotion. "Emotion moves us," said Sherrington, "hence its name." Each animal emits a specific odor peculiar not only to the individual, race and species, but also to the genus, family, order and class. These odors are the chief means by which one animal is able to recognize others. These specific odors arise from scent producing organs or glands, which are of three types: special scent glands, sweat and sebaceous glands. Insects have no sweat or sebaceous glands, but they do possess glands which have a wide bodily distribution, many being located on the surfaces of their feet. These produce odors which aid them to trail one another. I will not test your patience by reviewing all the different groups of the animal kingdom, but will merely refer to a few that to me seem most interesting. In the unicellular animals there is no actual sense of smell or taste. The reactions displayed by these low forms of life when they are brought in contact with either physical or chemical irritants are entirely due to chemotaxis.

Coelenterata.—Water hydra react to mechanical and chemical stimulations when they are brought into contact with their ten-

tacles, causing movements of the tentacles and mouth slits. If we put a little meat juice into an aquarium containing sea anemones, we may be sure that in a short time all the anemones will be most beautifully expanded. If one touches their tentacles with paper or stone, they move away. They are also able to perceive gases directed over the water containing them.

Vermes.—Worms also have an acute sense of smell. Their entire bodies are sensitive to chemical stimulation, but only the head is sensitive to odors.

Insects.—There has been a great deal of argument in relation to the location of the olfactory end organs in insects. There is, however, probably no doubt that they are chiefly located in the antennae, but not necessarily exclusively so. Odors play a very important rôle in the life of insects. In the first place, insects themselves produce odors for a variety of purposes: in the building of their nests, as contained in wax and resin; protective odors (against birds); poisons and enticing sexual odors; trail and recognition odors. Some insects give off an odor similar to garlic, others similar to camphor. Bedbugs and certain types of beetles are notorious for their offensive odors.

Butterflies.—Butterflies have the enticing odor developed to its highest degree. Fabre⁵ was the first to investigate this. A great female peacock moth, captured and placed in his room attracted on the first night of her captivity forty male butterflies of the same species, who were in search of a mate, and the second night twenty-four. In eight nights the female attracted 150 male butterflies of the same species. They did not go directly to the object of their search but flew aimlessly about as if trying to locate the source of an odor. When she was placed under a bell jar no male approached. In experiments with the banded monk moth the same thing occurred, even though such odors as naphthalene and lavender were placed in the same room. When the female was allowed to come in contact with gauze and was then placed under a bell jar the males would go to the place where the gauze with which she had been in contact was located. Forel⁶ carried out similar experiments with the same results.

Ants.—The ant is one of the most interesting of the insects, and its behavior has been closely studied. It has been shown that each ant hill or colony has its individual odor. If an ant from one hill is placed into another, he will be destroyed immediately, but if the antennae of the ants in this hill be removed this will not occur.⁷ If an ant is removed from his hill, his body bathed with the blood of an ant from another hill, and if he is then placed back into his own hill, he will be destroyed.⁸ He will also be destroyed if his body is bathed in alcohol and he is replaced before it has had time to dry. Forel⁹ has taken ants from different hills and shaken them together in a bag until they all had the same odor. For some time after this they got along quite well together, but when their natural odor appeared war was declared. Blind ants are also able to recognize each other when they meet. All of this shows that ants recognize each other by their sense of smell. It has been shown further, by Miss Adele Field¹⁰ that the olfactory sense which in the ant is predominant over all the other senses resides mainly in the last seven segments of its funicle—that is, the process at the end of the antenna. Each of these joints is devoted to the detection of a particular odor. For example, the odor of the nest is perceived by the last segment; the last but one discerns the age of the workers in the colonies, consisting of various families of the same species, and the last but two perceives the scent with which the ant impregnates her own trail. When the last segment is removed the ant will enter any nest and will consequently be killed. When the penultimate segment is amputated, she can no longer recover her own trail. It has been found that ants find their way back to their hills through their sense of smell. If their eyes are covered with varnish they still find their hill, but cannot when their antennae have also been removed. Blinded ants are able to return home, but require a little more time.

Bees.—We are indebted to K. V. Frisch¹¹ for his experimental work on the olfactory power of bees. He found that bees can smell all odors which man is capable of sensing, and with about the same degree of acuity. He was also able to determine that they depend upon vision in searching for distant flowers, but utilize their sense of smell for those near by. Buttel-Reepen¹² was

able to quiet a hive of bees who were under great excitement, due to the absence of the queen bee, by placing in the hive cotton which had been in contact with their queen, or by placing the dead queen back in the hive. When a new queen is put in a strange hive she must be protected until the bees become acclimated to her odor, or they will destroy her at once. Like ants, bees also recognize one another by their sense of smell.

Many insects are also enticed by natural and artificial odors. Fabre¹³ has recorded how some insects are lured to their death by certain insectivorous plants which exhale an odor similar to putrid beef. Insects are also attracted by the odor of plants on which they feed; the potato beetle will feed on horse nettle, jimson weed, tomatoes and other related plants when potato plants are wanting.

The control of noxious insects, such as grasshoppers, ants, olive flies, the Mediterranean fruit fly, etc., is made possible by preparing attractive baits. These baits are prepared by studying the likes and dislikes of the insects, which are distinguished largely by their sense of smell and taste. In some instances the insects are destroyed by poisoning the bait, others are controlled by repellant smoke, coal tar, petroleum and moth balls.

Fish.—The olfactory sense organs of fish differ from those of land animals in the anatomic structure of their end organs, in the olfactory mucous membrane and also in the chemical composition of their plasma colloids and lipoids. In land animals the latter are soluble in water, hence olfaction ceases when the surfaces of the olfactory mucous membrane are covered with water. In fish the odorivector is soluble in water and is brought to the fish's olfactory apparatus in this medium. There has been considerable controversy whether sea animals can smell, or whether with them it is all a matter of taste. A few experiments which I will cite would seem to prove that in many fish the sense of smell is quite acute.

Graber¹⁴ placed fish in water that was not deep enough to cover their olfactory end organs; then through a small tube he conducted to the olfactory apparatus various odors, such as asafetida and rose oil. The fish reacted at once and swam rapidly away. It is a well known fact that sharks can smell blood and will swim to-

wards it from considerable distance. Uexkull¹⁵ found that fish, which had not received any nourishment for several days, would after three minutes attempt to locate a dead fish which had been placed in a sack in the water. They would immediately find and swallow a dead fish placed in the water; if the fish were smeared with quinin, it would be expelled at once after having been swallowed.

Birds.—Birds have a very acute sense of smell. In fact, some of them surpass all living creatures in the keenness of this sense. Only a few examples will be given. Crows can detect food which is buried under the snow, and the buzzard's sense of smell is so keen that he can detect the decomposing carcass of a mouse while sailing in slow circles hundreds of feet above the earth. Vultures scent the same kind of food at incredible distances. Still more amazing is the statement of Pliny, who declared that carrion crows are able to smell odors which emanate from animals before they die. They frequently arrive three days in advance and await the death of the stricken creature.

Mammals.—We all know how important the sense of smell is to all of the carnivorous animals. In the smaller land grubbing animals the sense of smell is of the highest importance; the other senses being an auxiliary to this sense. It is, however, essentially a land sense. The mammals who live wholly or partially in the water, such as the whale and the dolphin, possess a very rudimentary organ of smell; in fact, the olfactory mucous membrane is absent in the whale. We find in animals, as in insects, special glands which produce specific odors, both for defense and allurements, for example, the odor of a skunk, musk ox, etc.

Even early in life, many animals are able to track their prey. The opossum is able to do this during his first year. Kangaroos have even a finer sense of smell than deer, and when blind find their way about by the aid of this sense. The fox has an extremely fine sense of smell, much more sensitive than that of a dog, coyote or wolf. All dogs are nose animals, with the exception of the greyhound. An elkhound is able to smell an elk at the distance of one and a half kilometers. The police dog's ability to follow tracks has probably been overestimated. It is not likely that he can follow a track that is over three hours old. Dogs,

like people, vary in the acuity of their senses. They smell of everything with which they come in contact, and it is interesting to note that they do not seem to accept anyone, not even their masters, until they have satisfied themselves by smelling them.

Many animals have notoriously poor eyes, and in them the sense of smell is of even greater importance. This is true of a number of the larger mammals, namely, the African elephant, rhinoceros and the bear. The monkeys have a well developed olfactory apparatus, but as they ascend in the evolutionary scale this apparatus recedes in development. All monkeys smell their food before eating it. The orangoutang and the gorilla use their sense of smell much more than man. Not only is the sense of smell more important with monkeys than with man, but it also produces greater reactions in the animals. Oetzen¹⁶ observed that the gorilla was very sensitive to the things that had a pleasing odor, such as rose leaves and perfumed pomade, and seemed to consider them as delicacies. Chimpanzees and other varieties of apes enjoy smoking. The orangoutang are often fond of wine and beer. Some of the larger apes rub their bodies with strong smelling herbs, such as onions, and then seem well pleased with themselves. We have here the first introduction to perfumery.

It has been observed that many of the larger African animals become enraged at the odor of certain individuals but are not at all disturbed by others. It has already been pointed out that the odors of an individual or animal may vary with his emotions. Mukerji, in his book, "Ghand, the Hunter," stresses the significance of odor in relation to fear. He outlines a course of treatment to be followed by the hunter, who has once succumbed to the fear of an animal, in order that he may regain the necessary confidence not to give way his sense of fear to the animal which is attacking him. This theory may explain the reason that some people are constantly being attacked by dogs, as in these cases the individuals are always afraid of these animals, and it also explains the reason for the previous observation in regard to the larger African animals.

I recently received a letter from a very prominent biochemist with whom I had previously discussed this question. He stated

that he had possible evidence in support of this idea, in that recently a rather cowardly puppy that he owned was attacked by another dog in an inclosed space in his home, and when one of his friends and he were separating the dogs, the former commented on a peculiar odor which he also had noted but which he had never observed before.

Anatomy.—The anatomic structure of the olfactory end organ is very simple, especially when we compare it with the end organs of sight and hearing, and seems but little altered from its primitive state.

The olfactory end organ is localized in the upper portion of each nostril. The olfactory mucous membrane covers the upper portion of the septum and the mesial surface of the upper turbinate and a portion of the middle turbinate bodies, and is covered with nonciliated columnar epithelium. Embedded in it are numerous tubular and often branched glands, the glands of Bowman, which secrete a fluid which covers the entire olfactory mucous membrane, and probably plays an important rôle in olfaction. The epithelium covering the olfactory region consists of: (1) Supporting cells containing a yellow pigment, (2) spindle shaped olfactory cells, each cell of which gives off a peripheral and a central process, the former, which is rod-like, being surmounted by a pencil of short filaments termed the olfactory hairs. At the free margin of the olfactory cells is a limiting membrane through which the hairs project. They are comparable to the rod and cone layer of the retina. The central process passes inward and is continuous with a fibril of the olfactory nerve; (3) the basal cells, which are branched and lie in the basement membrane between the deep extremities of the supporting and olfactory cells. The mucous membrane of this area also contains numerous branches of the trigeminus.

The olfactory nerves traverse the cribriform plate of the ethmoid bone and are first lodged in the bony canals or grooves situated on the inner and outer walls of the olfactory area, and after reaching the deep surface of the mucous membrane are continued into the central processes of the olfactory cells.

The olfactory bulb lies on the cribriform plate of the ethmoid and here receives the olfactory nerves. The nerve cells in the

bulb may be compared to the ganglion layer of the retina. Posteriorly the bulb is continued into the olfactory tract which divides into three roots.

Since our knowledge of the course of the olfactory fibers has been obtained from specimens stained by the Weigert method and we now know that this method is inadequate to determine their complete ramification, we can only accept as provisional the following outline of these fibers in the cerebral cortex. The olfactory fibers which arise in the olfactory mucous membrane of the nose are split up in the glomerulus where they come into communication with the mitral and buschel cells of the olfactory bulb. The axis cylinders of these mitral and buschel cells and also the axis cylinders of the cells which are found in the olfactory tract form the tract fibers which now pass into the following portions of the brain:

1. In the anterior portion of the gyrus hippocampus through the stria olfactoria lateralis.
2. To the basilar olfactory area of the opposite side through the anterior commissure.
3. In the septum pellucidum.
4. In the subperforata anterior.
5. In the brain stem.

The most important of these are the fibers which pass into the stria olfactoria lateralis in the gyrus hippocampus, because it is thought that the primary olfactory center is located here.

It is uncertain whether there is a direct communication through the anterior commissure between the olfactory tract on the one side and the olfactory cortex on the opposite side. It is quite likely that such a communication does exist, either with the bulb or tract of the opposite side, in which case there would be an indirect communication between the fibers of the one side and the olfactory cortex of the opposite side. It is, therefore, quite possible that there is a direct, and possibly also, a crossed bulbo-cortical tract. The remaining fibers of the tract form bulbo-cortical communications.

Cajal¹⁸ has made a very careful histologic study of the olfactory centers of the brain and has come to the conclusion that the

chief olfactory center is in the uncus. He has found that the uncus and the other parts of the gyrus hippocampus are in close communication with each other, and in addition are also connected by association fibers with ammons horn and the fascia dentata, so he also regards these cortical areas as cortical olfactory centers. These centers do not have the same physiological level as the chief centers in the uncus but act as association centers. Thus far experimental work has not helped to prove the location of the olfactory centers. Whereas, Luciani¹⁹ found disturbances of smell in cases which on postmortem showed a lesion in ammons horn or in the gyrus hippocampus, Ossipow's²⁰ findings were negative in similar cases. Marcus has also seen cases which had no disturbance of olfaction but where a lesion of the uncus was found. Henshen²¹ long ago pointed out that on account of the bilateral innervation of the olfactory apparatus it is possible to have a normal sense of smell, even though there is a total destruction of the uncus on one side. Jackson²² and Colman,²³ Sander,²⁴ Astivazaturow,²⁵ and others have carefully investigated cases of abscess and tumors of the temporal lobe in which olfactory and gustatory aura preceded epileptic attacks, but these examinations have not helped to clarify this problem, due to the fact that in either of these conditions it is impossible to be certain of the extent of the injury to the brain by edema, inflammation and pressure. After taking into consideration the extent of the cortical olfactory centers and their communications, Brunner²⁶ came to the conclusion that although the olfactory cortex of the macrosmatic animals has reached a greater quantitative development than in man, it cannot be stated that the olfactory cortex in microsmatic man has a merely rudimentary development from a qualitative angle.

The cortical olfactory centers also send out commissural, association and projection fibers. The projection fibers afford a communication between the cortex and the subcortical centers; the commissural fibers a communication between two identical cortical areas in both hemispheres; and the association fibers produce a communication between two cortical areas in the same hemisphere. The illustrations, one and two, will show that the olfactory bundle of ammons horn is not a pure association system

between the limbic lobe and the olfactory lobe, as was formerly believed by Zuckerkandl,²⁷ but that this bundle must be considered as a mixed bundle in which association as well as projection fibers are to be found. This practically agrees with the findings of Dejerine.

It must also be mentioned that through the cingulum, which is designated by "x" in illustration one, the gyrus fornicatus is brought into association with the olfactory cortex. The communication between the olfactory bulb and the subcortical centers is very much poorer in man than those between the bulb and the cortex. In the macrosmatic animals these communications are very much better developed. The olfactory nerve differs from the other sensory nerves in that the latter have a well developed ganglion in the optic thalamus, while the olfactory nerve has only a poorly developed communication with the subthalamic regions and only indirect communication with the thalamus and that through the inferior bundle of the thalamus, the fornix and the taenie thalami. Here again the olfactory communications with the optic thalamus are very much better developed in the macrosmatic animals.

According to Muck,²⁸ Henschen²⁹ and others, it seems that all sense systems have primary and secondary sense centers. Lesions of the secondary sense centers of olfaction probably produce the so-called functional disturbances of smell. Here we do not have a loss of smell but a loss of the ability to recognize given odors (agnosia). Henschen³⁰ searched the literature to classify this phase of the subject and found nineteen patients who had no loss of their sense of smell but who could not recognize odors. An analysis of these cases tends to support Bechterew³¹ and Cajal³² that secondary smell centers exist and that lesions thereof produce an agnosia.

There is another form of smell disturbance which results from lesions of the secondary smell centers, namely, smell hallucinations. Marcus³³ reported a case in which a man, 37 years of age, had severe epileptic convulsions which were preceded and followed by hallucinations of smell, a strong, sweet, nauseating odor. A postmortem examination showed a neoplasm which had

destroyed most of the gyrus hippocampus, including the uncus and ammons horn. A number of cases have also been reported with smell hallucinations following brain injury, as in Akutzin-sky's³⁴ case, in which a bullet was found in the anterior pole of the gyrus hippocampus at the turning point of the uncus. There are a number of cases reported in the literature suffering from epilepsy where extensive lesions of ammons horn were found but no smell hallucinations occurred. On the other hand, in all cases of epilepsy with smell aura, ammons horn was found involved; whereas, in tumors elsewhere in the brain no such hallucinations were observed.

Physiology.—I have stated previously that the olfactory end organ occupies a position high up in each nasal cavity. This location protects it from the dust and dryness of the inspired air, whose main current passes through the nose below this area. The moist and filtered air that is breathed out flows directly over the olfactory cells, which allows us to sense the flavors from the food and drinks we swallow. The act of smelling can therefore be accomplished through both the anterior and posterior nares. Sniffing is usually necessary to force the odoriferous particles up to the olfactory membrane. Hence, under the ordinary conditions, we are not cognizant of the odors which surround us. As stated before, we sense the flavors through our posterior nares. During the act of swallowing, the soft palate moves up and separates the upper from the lower pharynx, but expiration immediately follows the act of swallowing, and the various flavors are directed upward to the olfactory cells.

In addition to the olfactory organ, we have taste buds in the upper portion of the nasopharynx. The air which passes through the nose bearing gaseous taste substances may therefore produce a sensation of taste. Nasal taste is not identical with that experienced by the papilla in the tongue, the nasal taste being more sensitive. Also it is stimulated by smell substances which are in a gaseous form, while those appreciated by the tongue must be in liquid solution. Again odors such as are produced by certain oils from flowers, fruits, etc., may taste sweet or sour to the nasal taste, but if the same substance is placed on the tongue may taste bitter. We can therefore differentiate odorous substances

which stimulate the olfactory nerve endings exclusively; others which stimulate both the olfactory and gustatory nerves; still others which stimulate the olfactory and sensory (tactile) nerves, and finally those which stimulate the trigeminus nerve exclusively.

The fact that smells are transmitted through space like light and sound has suggested the possibility that they may depend upon a vibratory movement of some medium. This theory, which has been brought forth by different investigators, is apparently incompatible with the facts. Nevertheless, my paper would not be complete without a review and criticism of the thesis of Heyninx,³⁵ which has been largely taken from a paper on this subject by Dan McKenzie.³⁶ This so-called undulatory theory of odors holds that the odorous molecules come into contact with the olfactory mucous membrane by virtue of their own intramolecular atomic vibration and that the ultimate odorous energy is a vibratory energy having a definite wave length which is constant for the same odors. In compound chemical bodies the atoms are grouped in certain definite morphologic forms, and these atoms are in a constant state of vibration, repelling and attracting each other. It seems quite likely that these vibrations may communicate some of their energy to the ether to form ethereal waves, as do the vibrations of luminous bodies. Heyninx assigns a place to the odorous waves in the ultra-violet region of the spectrum, and therefore it would appear, if his views are correct, that the olfactory sense begins where the visual sense leaves off. Heyninx has advanced the following facts and arguments to prove his theory: Spectrum analyses of odors in the gaseous state, which are found in the ultra-violet region by means of photography, have shown that odors absorb more or less of the ultra-violet rays of light. Not only is this so, but it is claimed that the position of the absorption bands shows some degree of correspondence with what is surmised to be the period of their intramolecular vibration and also with the quality of their odor.

Certain odorous bodies are known to give off different odors according to their concentration. Dilute thymol smells of thyme, whereas a bottle filled with thymol crystals has a feculent odor. When a concentrated solution of thymol is exposed to the pene-

tration of the ultra-violet rays, Vierordt's curve is seen to be displaced towards the region of the lower wave lengths—that is, towards the visible violet. This corresponds with the position occupied by Scatol. Again when the olfactory apparatus is exposed to too great a quantity of perfume, nothing but an indefinite odor can be perceived. In harmony with this is the fact that when a hyperconcentrated odor is submitted to the spectrum it is seen that the ultra-violet rays are entirely absorbed, without any separation into the usual absorption bands.

As in colors and sounds, there is harmony between certain kinds of odors, and some authorities go so far as to refer the quality of certain odors to the presence of harmonics similar to those which give timbre to musical tones. Furthermore, as one tone may silence another, so may one odor neutralize another, namely, iodoform and coffee. It is a law of physics that the intramolecular wave length of a body absorbent of color corresponds in period to the wave length it absorbs. In other words, when waves of certain length meet waves of similar length they absorb them. If this is true, and if odorous bodies absorb ultra-violet rays, then obviously their intramolecular vibration must be equivalent to the vibration of the ultra-violet rays of light.

Heyninx stresses the fact that the olfactory mucous membrane contains pigment, and when this pigment is absent, as in albinos, there is a loss of sense of smell. He states that he measured these olfactory granules and that their diameters measured between 0.2 μ . and 0.3 μ . This is the approximate size of the wave length of the violet and ultra-violet rays. These granules struck by the olfactory waves are activated by them, the longest waves activating the largest granules. This in turn sets up a stimulation which is carried on to the centers in the brain.

The following are points which tend to disprove the theory of Heyninx and others who agree with him. It has been pointed out by McKenzie that bodies may be accurately measured as low as 0.7 μ ., but below that point an optical effect is produced, even in the best microscopes, which renders precise measurement difficult or impossible. Forty years ago Tyndall experimented with odorous vapors and made the observation that these vapors

absorb radiant heat rays—that is, the invisible infra-red rays, which are at the other end of the spectrum. No experiments have been made to disprove this. McKenzie also points out that Heyninx has not determined whether odorous vibrations obey the same laws as ultra-violet light.

It is difficult to conceive how ethereal waves, akin in form and differing only in length, can give rise to mental sensations fundamentally unlike as in vision and olfaction.

Finally, when odors are freed from an odorous body they spread by diffusion and by air currents. The rapidity of the diffusion varies greatly. Some odors, like mignonette and ether, spread over a great distance within a few seconds, while others remain in the vicinity from which they originated for a long time—e. g., roses and naphthalene. Roughly, the rapidity of the spread is in inverse proportion to their molecular weight. Odors do not spread against the wind. Again, the perception of odors varies with the barometric pressure.

In a general way, the great majority of investigators believe that odorous bodies emit particles which are in a gaseous form. When inspired they are dissolved in the liquid which is secreted by Bowman's glands and in which the cilia of the olfactory cells float. These molecules are probably absorbed by the cilia and are then carried to the olfactory cells.

Gleg has estimated that the reaction time for auditory sensations is from 0.12 to 0.15 of a second, whereas the reaction time for smell is as much as 0.5, only one sensory stimulus being slower—that of pain, which occupies 0.9 of a second.

Olfactometry.—A number of authors, including Proetz³⁷ and Zwaardemaker,³⁸ have given us notable contributions on this phase of olfaction. The author will not attempt to review their work in this paper, but wishes to point out that odorous sensations are called forth by almost immeasurably small amounts of odorous substances. Mercaptan is one of the most strongly odorous substances known. This liquid can still be detected when 1/460,000,000 of a mg. has been evaporated in 50 cc. of air. Musk can give out its odor for years without an appreciable loss in its weight.

We have been led to believe that in modern man olfaction is a decadent sense. A careful survey of the literature does not seem to support this theory. Alexander von Humboldt⁴¹ stated that the Peruvian Indians were able to follow trails by their sense of smell, but Darwin,⁴² who tested the same people, determined that their ability to do this was due to their keen sense of visual observation. Lumholtz⁴³ is of the same opinion. There are in the literature numerous other observations which show that primitive people do not track by their sense of smell. Landor⁴⁴ in his expedition was pursued by natives who, at different times, were within a few feet of him and his men, but they did not detect them, due to the absence of tracks, and were only able to find them when they discovered his tracks by eyesight. Swen Hedin⁴⁵ had a similar experience. Finally, the members of the Cambridge expedition to the Murray Islands of Australia found that the natives' sense of smell was no better than the Scotch who tested them. It is true that some people have a very keen sense of smell, and when this sense is cultivated they are able to detect odors which seem utterly impossible to another individual.

Hagenbeck⁴⁶ describes the capture of pythons and other snakes through the sense of smell. The snake catcher is able to scent the presence of a snake in its hole. The reptile is then dug out early in the morning when it is cold and inactive. It is a well known fact that hunters are able to smell game at a considerable distance; for example, elk, goats and sheep. Roosevelt⁴⁷ describes smelling an elephant in a thicket where he could not be seen. I will now cite a few extraordinary olfactory feats of Europeans. James Mitchell⁴⁸ was able to recognize people by their odors, so also was Laura Bridgman.⁴⁹ Other blind and deaf people are not only able to distinguish individuals, but can determine whether these people are sympathetic or antagonistic by their odors. Erman⁵⁰ was able to determine that a Chinese had recently left a room into which he was taken blindfolded; Preyer⁵¹ could even identify individuals by their odor.

Classification of Odors.—A great many attempts have been made to classify odors, and up to the present time none have been satisfactory. In fact, no great improvement has been made on the following classification of Linnes (1756):

1. Odores aromatici—i. e., cloves and laurel leaves.
2. Odores fragrantis—i. e., jasmin and tuberose.
3. Odores ambrosiaci—i. e., musk and ambergris.
4. Odores alliacei—i. e., onions and garlic.
5. Odores hircini—i. e., valerian and chenopodium.
6. Odores tetri—i. e., nightshade and coriander.
7. Odores nausei—i. e., hellebore and colocynth.

In this classification Linnes divided the odors into seven classes, in each of which the odor resembled some plant or plants. This classification is very incomplete, as will be pointed out later. I will next give the Zwaardemaker classification. He divided the odors into nine classes:

1. Ethereal—i. e., acetone, chloroform, ether.
2. Aromatic—i. e., camphor, eucalyptus, nitrobenzol.
3. Balsamic—i. e., vanilla, geraniol, terpinol.
4. Musk-like—i. e., trinitroisobutyltoluol (synthetic musk).
5. Garlic-like—i. e., mercaptan trymethylamin.
6. Empyreumatic or burnt—i. e., toluol, kresol, naphthalin.
7. Hircin odor—i. e., caprioic acid.
8. Unpleasant—i. e., puridin, chinolin.
9. Nauseating—i. e., skatol.

Henning,⁵² in criticising this classification, states that Zwaardemaker compiled the same from a study of the literature and not on the basis of experimental research. He points out that unpleasant and nauseating odors are not smell characteristics but sensory complexes. He further holds that the classification does not cover all of the subjective olfactory qualities.

Superficially a chemical classification seems more rational, but it is a well known fact that odorous substances which are closely related qualitatively belong in entirely different chemical groups, and again, members of the same group have an entirely different odor.

Probably the best known classification is that of Henning.⁵³ He has attempted to find the fundamental odors, similar to the primary colors. According to his investigations, there are six fundamental or primary odors: Flowery, fruity, putrid, spicy,

resinous, and burnt, each one of which may pass over into every other through transitional odors—"Henning's smell-prism." There has been a great deal of work done to prove or disprove the value of this classification. McDonald's⁵⁴ findings only correspond with Henning's to a certain extent. Findley⁵⁵ agrees with McDonald. According to Bornstein,⁵⁶ if this theory were true, the odors which would combine at any of the six points of the prism—for example, fruity and flowery—would be similar or would be a combination of the two odors. As a matter of fact, there may be a great number of odors which are more or less similar and yet the quality flowery and fruity or fruity and putrid, etc., cannot be noticed. According to this author, it is not possible to make a classification of odors, as they are a phenomena which stand in the same category as noises. One would be obligated to state that he had heard a clashing or a smashing noise.

One of the latest classifications has been contributed by Crocker⁵⁷ and Henderson, chemists in the perfume industry. They claim that there are four types of odors: fragrant, acid, burnt and caprylic, but that most odors are of a mixed type. They classify each smell by determining its position upon a nine point scale of resemblance to each of the four standards. Thus every odor tested is described by a combination of four digits.

Compound Odors.—In blending odors as well as colors it is necessary that they be harmonious in order to produce an esthetic result. In the case of a bouquet, a few selected flowers added to many may improve or alter the scent of the whole. Laboratory experiments bear out this observation. When musk and opium or musk and listerine, or iodine and ylang-ylang, or iodine and camphor are mixed the resultant odor is simple and unanalyzable; it resembles the component odors but cannot be resolved into them. On the other hand, there are odors which when they are mixed neutralize each other—e. g., carbolic acid and the stench of a pulmonary abscess; the odor of iodoform by balsam of Peru.

Adaptation to Odors.—It is interesting to note that odors of the most insistent kind fade out in a comparatively short time,

if the stimulation is kept up without intermission. The fact of adaptation to stimulus is perhaps more in evidence in the case of smell than it is even in that of vision. Workers in tanneries, cheese factories, fish markets, etc., are as a rule quite unconscious of the odors that surround them. The fading out of a given sensation does not mean the arousal of its complementary; there are no negative after-images of smell.⁵⁸ The effect of adaptation is simply to increase our sensitivity for certain odors and to reduce or destroy it for others. Thus it has been found that a partial adaptation to cedarwood, or tolu, or beeswax renders the nose more sensitive to the smell of india rubber. On the other hand, adaptation to iodine leaves us insensitive to the odor of eau de cologne, absolute alcohol, heliotrope and oil of caraway. In this way a continuous adaptation of the sort mentioned above may materially change the world of odors. The user of perfumery, the hospital attendant, and the smoker will be peculiarly susceptible to certain scents and obtuse to others. It has been stated that smokers possess only two-fifths of the normal sensitivity to odors.

Olfaction and Sex.—The influence of olfaction upon the sexual sense is pronounced in the lower animals, as we have already pointed out. As far as man is concerned, little or nothing is known. Havelock Ellis, after making an exhaustive inquiry, came to the conclusion that if a lover loves the aroma of his lady, that is because of his love and not because of the aroma. In other words, the attraction is not primarily an olfactory one.

Ethnologic Factors and Olfaction.—The human body, apart from its excretory products, is a source of odors which arise chiefly from the secretions of the skin. The individual is more or less anosmic to these skin smells, both for his own person and those of his fellows, but during perspiration these odors become more pronounced and therefore are more apt to be perceived. The secretions of the skin vary, depending upon a variety of factors: (1) location, for example, the hairy parts give off a different odor than the smooth skin; (2) age—there is a distinct change in the odor at puberty; (3) emotions cause a change in the odor of the secretion. If the nose were sufficiently well trained it might be possible to differentiate between saints and

hypocrites. Foods, drinks, drugs and the personal state of cleanliness all produce changes in an individual's odor.

Each race has its own peculiar odor, which cannot be altered by bathing.⁶⁶ The odor of the negro has been described as a rancid-ammoniacal alkaline odor. The Chinese have an odor similar to garlic or onions. The Mohammedan smells like mutton.

Olfaction and Medicine.—There is a change in the normal odor of the body brought about by toxins in the blood stream. The sense of smell, unlike that of sight or hearing, is used very little in making a physical examination of a patient. Certain morbid states can be detected by their odors; like other methods of diagnosis, it requires experience and a sharp sense of smell. Unfortunately, the description of these odors is largely personal, since the mental responses vary with the individual. Many authors have described the acid smell of rheumatism, acetone on the breath, and speak of the close, mawkish odor of typhus fever, while others describe it as resembling rotting straw or an offensive, pungent, ammoniacal odor. Flavis resembles the smell of mice. Some seem to think that diphtheria has a characteristic odor. Measles have a musty odor. From the preceding statements, it is therefore obvious that the sense of smell has a very limited value in the diagnosis of disease.

Olfaction and Its Relation to Our Likes and Dislikes of Foods.—Although discrimination between odors is largely a matter of training, reflex paths for affective reactions to olfactory stimulation are formed before birth, and observation in both animals and man show inborn (racial) likes and dislikes. Henning⁶⁷ states that our likes and dislikes, as far as food is concerned, do not depend upon us, but in a larger measure is governed by the dead, our ancestors, and we must search in the records of antiquity if we wish to understand the reasons for this.

First of all, we have racial peculiarities and habits. The majority of the South and East African Negroes, many Mongols, and the Navaho Indians despise fish. The following races have an aversion for pork: Jews, Mohammedans and Laplanders. Some primitive people (Australians) eat meat which has undergone decomposition. Europeans are exclusive in that they only

enjoy high game and limburger cheese. These illustrations could be continued indefinitely. Similar conditions hold true in reference to cleanliness. In the Uganda the natives rub their bodies with clay, but despise bathing in water. The Obbos of Central Africa wash in urine. The Somali enjoy the saliva of strangers. The excrements of the Dalai Lama are considered fragrant.

The origin of these sensory likes and dislikes is largely due to a magical complex, which in the beginning arose as a magical command or taboo, and later became a custom due to its continual usage or observation. Finally even the memory of the custom faded and only the traditional sensory like and dislike remained. These habits may become stronger or weaker, being modified by new association, fashion, etc.

In addition to the magical complex relative to the use of certain foodstuffs and beverages, similar causative factors also prevail in reference to the use of incense, perfumes, etc. In this sense every flower or plant has its psychologic story. A few of the best known might be mentioned. Rosemary, in the hoary past, was used to decorate the house gods. It is still used by many European peasants as a bridal wreath and is also placed on the coffins of the dead; consequently, it is a symbol of love and constancy. Myrtle was sacred to Aphrodite, the goddess of love, and to the earth god, Demeter. It was also considered the emblem of youth and beauty. The German folk used it as a wreath during the marriage ceremony. The laurel was sacred to Apollo and was supposed to protect against lightning, fever, the plague, pest and other evils.

Thus we see how flowers and plants have a variety of magical associations which have faded and there remains only that indescribable something to be handed down to future generations. Julian Hirsch⁶⁸ cites the following example, which illustrates the effect of taboos as a causative factor in our dislike for certain foods. The heathen Germans were very fond of horse meat and made offerings of this meat to their gods. In 731 Boniface appeared before Pope Gregory asking that a ban be placed on eating horse meat, as he thought that the eating of horse meat was an influence towards a return to paganism. The ban was pub-

lished and had its desired effect; very little horse meat was eaten after this. Even as late as 1853, in spite of a severe famine in Saxony, the power of the taboo prevented the use of this meat for nourishment. The same is true of pork in relation to the Jews. Similar proof of a taboo can be brought forth relative to the cat, dog, mouse, weasel and stork.

The whole question of like and dislike is very irrational. One does not hesitate to kiss the hair of his loved one, but would dislike very much to find her hair in his soup. One who may dislike using another's water glass will drink from a communion cup of wine. In addition to the magical command or taboo, habit plays an important rôle in the formation of our likes and dislikes. One can become accustomed to very foul odors; also people may at first dislike certain foods and drinks, but in time learn to enjoy them. A child will not like tobacco, coffee, wine and many other articles of diet, but will gradually become accustomed to them by seeing his parents enjoy them. In this instance the outcome is due to training and may be considered as a conditioned reflex. Each individual manifests certain reactions to different olfactory stimuli, which are based on racial and individual experiences, the result being the sum total of his likes and dislikes. The individual reactions are referred either to the odorous body itself (osmyl) or to associated senses, or to associated but more remote ideas.

Nasal obstructions of any character and physical factors, such as the degree of dampness of the atmosphere, play a rôle in these olfactory reactions. Again, optical factors play a rôle in the recognition of and the sensory reaction to odors. It is impossible to recognize white wine from red wine in the dark. If one attempts to eat, in the dark, food with which he is not acquainted it will be found that it has little or no taste and that there will be little or no odor connected with it, whereas the touch and temperature sense is normally experienced. Helen Keller has pointed out that when the blind perceive an odor they have a desire to touch the osmyl and seem thereby to receive a better mental impression of the odor.

Olfactory Memories.—Ribot,⁶³ in his investigations relative to smell memories, ascertained that in a group of subjects which

he had examined, 40 per cent could not revive any olfactory image. Forty-eight per cent could recall some but not all, and only 12 per cent could recall all or nearly all of their smell memories at will. In some instances these subjects were able only to recall the olfactory memory, in others there was in addition a visual picture of the osmyl. Many individuals must first see the smell body in order to recall the olfactory memory. The anthropologist, F. von Luschau,⁶⁴ could without difficulty revive the smell images of the different bazars of the Orient and was able to differentiate between the odors of the bazars of Aleppo, Damascus and Cairo. Ernest Shackleton,⁶⁵ in a speech at Paris, made this statement: "I can remember the odors of the countries which I have visited in my travels, and whenever I smell these odors I associate them with these places. The odor of China is like the emanation from the yellow race plus the effect of the hot sun on the rice swamps. Ceylon has the spicy odor of the betel nut; Japan, of ham and eggs; Arabia reproduces the odor of rancid butter; St. Petersburg, like burning wood." It is a well known fact that tasters of tea, wine and tobacco must have exceptional smell memories, as must perfume chemists. Apothecaries also often develop this faculty.

Mental Reactions.—The secondary sensory content of consciousness resulting from the stimulation of the olfactory end organ, namely, the emotional reaction—the associative imagery aroused—the pleasantness and unpleasantness of the odor—must be considered separately from the olfactory sensation itself. As an example, one might cite that the odor of jasmine is generally accepted as being pleasant, yet the opposite may be true if it is associated with some unpleasant occurrence. The homely smell of fried ham and eggs is usually an attractive one at the breakfast hour, but on the morning after, might be very repellant. In the first instance we have a previous experience conditioning the emotion. In the second we have an organic stimulus from the viscera or the action of toxins in the blood stream causing the emotion.

In some individuals odor produces an awareness of sensations which belong to a different sense (synesthesia). Kenneth⁶⁶ classifies these associative reactions as follows: Color, gustatory, audi-

tory, tactile and thermic sensations. He found that in one individual amyl acetate produced the sensation of blue. Origanum produced an opalescent green color sensation in another individual. The sensation of a high note was caused by terebene, and that of a middle note was experienced by another subject on stimulation with camphor. Many subjects, on comparing odors, experience the sensation of pitch, and experiments show that sandalwood oil, cedar wood oil, origanum and terebene could be serially arranged according to the sensation of pitch—the arrangement being in the order of the boiling points of these osmyls. Henning states that Scriabin, the Russian composer, saw colors and smelled odors in his compositions.

It is a very well known fact that odors possess a remarkable power to revive past experiences, and nearly all of us have had smell associations. I have had two smell associations which are particularly pronounced. The smell of new mown hay brings to my mind a little creek in Southern Michigan, where I first became acquainted with this odor. The smell of roasting coffee takes me back to a street in Chicago, where coffee is roasted. Both of these associations are constant. It must be clear that if odors give us on some occasions vivid recollections, they must do so by virtue of some peculiarity of the odor or in the circumstances under which they have been perceived. The odor must be one which is not very frequently experienced, especially under varied conditions, otherwise the association with the one set of circumstances would not stand out. If we examine the mental processes set going by the smell, we shall find that the emotion comes back first, and is usually followed almost immediately by the memory picture. Occasionally it may take some time to recollect the experience with which the smell was originally associated; sometime, especially if the experience was in any way painful, it may elude us entirely, and we are aware only that certain smells are unaccountably unpleasant.

As stated before, odors have the power to bring back old memories. Only a small number of the innumerable olfactory stimuli inspired with every breath cause a reaction of which the individual is attentively aware. However, that a reaction has been caused is demonstrable by applying identical or similar stimuli

later, when the conditions prevailing formerly are reproduced and the circumstances may more or less fully become the content of an image, often but not invariably of a visual character. The fact that most olfactory associations are founded unconsciously makes their investigation one of considerable importance, especially when linked up with olfactory associations occasionally recorded in dreams.

On the basis of these investigations Kenneth holds that the similarity between smell associations and dream phenomena makes it appear that odors should be used in psychoanalytic practice for detecting the presence of a complex. Experiments made with a galvanometer have been successful, and complexes have been brought to the surface by various smell stimuli. It is interesting to note that a fear complex of about thirty years' standing was revealed by allowing the subject to smell camphor. There was an extreme psychogalvanic reflex in this instance, and the nature of the complex was quickly elicited by interrogation. In another subject the smell of rose oil recalled a serious motor car accident in which the subject received an injury causing an atrophy of the optic nerve of one eye. The content of this associative reaction was extremely large and recalled the accident which had occurred nine years previously with such vividness that the rose effect was completely swamped. There had been a garden of roses in full bloom at the scene of the accident, as the subject remembered on introspection but not before. Kenneth also thinks that odors would be effective in the treatment of certain neuroses by inducing proper frames of mind. As an example, the odor of roses has a soothing effect, causing a sense of well being in most subjects. Musk is a veritable chameleon of odors, sometimes pleasing, sometimes irritating, at other times causing a reflective mood. The tang of pine oil, bracing and friendly; ferric valerian, uncomfortable; vanilla, drowsy, etc.

Olfaction and Speech.—I have previously stated that the sense of smell lacks an individual vocabulary, and I will now try to show the reason for this. It is, of course, a simple thing to undergo the experience of smelling odorous substances, but to describe what one feels is often extremely difficult.

Head's⁶⁰ latest view is that speech is not a function of a definitely localized speech center in the cortex but is rather to be considered as a highly developed mode of behavior to which we have given the term of "symbolic formulation and expression." This depends on a group of functions for which the integrity of large areas of the cortex is necessary.

The modern conception of the central nervous system, considered physiologically, is that of a series of levels of integration.⁵⁹ The lower levels sift out the afferent impulses which are concerned with the production of mere automatic reactions, such as the spinal reflex. In such cases an afferent chain, consisting only of a comparatively few neurones and synapses, is required for the integration of an impulse, so that it may act on a final efferent path. The higher activities of the human mind, such as judgment, the reasoning process and speech, belong to much higher physiological levels, and involves a much larger number of neuron combinations. Head considers that speech (symbolic formulation and expression) occurs at a "level of integration far above that of movement, or even of such specialized form of sensation as vision or hearing." The development of these higher levels has been associated with the growth of the neopallium. As a result, impulses originating from the receptors of vision, touch and hearing can be highly integrated, so that the sensory images and the discriminated qualities belonging to them can be formulated into a symbol which is expressible in the spoken word.

Acquired aphasia is the result of an anatomic lesion interfering with the function of various levels of cortical activity, and it may assume several forms. The variety described by Head as verbal aphasia is of special interest in regard to the subject matter of this paper. In this variety, naming is impossible, because the adequate verbal symbol cannot be reproduced. The more abstract the symbol, the greater is the difficulty, as, for instance, the names of colors. In a case of verbal aphasia described by Head, the patient, though unable to name colors, could describe them appropriately if he were allowed to employ a simile of metaphorical phrase. Thus, he may fail to recall the name for "black," but describes it as "what you do for the dead." Such aphasias, how-

ever, can match colors shown to them, although they cannot name them.

A corresponding aphasia is met with naturally as regards smell. There are no words available for naming its phenomena except those of simile and metaphor, but odors from identical sources can be matched and recognized. It would seem that the higher anatomic planes and integrating levels necessary for speech do not exist in the *archi-pallium*, so that the symbolic formulation of odors cannot take place. The aphasia is a natural one compared with acquired aphasia, in which a dissolution of the functions of the higher levels of the *neo-pallium* is brought about by anatomic disruption. In some cases of acquired aphasia the condition of function brought about corresponds with that normally associated with the primitive olfactory cortex.

According to Halliday, an individual can express in words his conscious reactions to odors in three ways only: (1) by simile or metaphor, (2) by words denoting emotional response, and (3) by words signifying a crude appreciation of the intensity of the stimulus. (1) If an individual recognizes an odor and is able to associate it with its source he is limited to a kind of simile when he attempts to name it—i. e., "it smells like a rose." If he is not acquainted with the odor he cannot formulate a speech symbol for it except in terms of an environment with which he could associate it. Thus, on smelling a rose the odor might be described as flowery or like a florist shop, etc. If an adjective is required instead of a simile to describe an odor, it becomes necessary to employ a word properly belonging to the quality of other senses—that is, a metaphor is used. Thus we speak of a musty smell because we have experienced a similar olfactory sensation in coming in contact with a mouldy substance, the mould being recognized through the sense of vision. Chesterton⁶¹ speaks of the brilliant smell of water. The adjective being metaphorical; "brilliant" is a visual attribute of water but not of the sense of smell.

The inability to name a smell is not due to the limitation of the English language alone. The French poet Baudelaire showed an unusual preoccupation with odors, and wrote some of his finest verse round them. But he did not succeed in harnessing their

qualities into words. He was compelled to use metaphors and similes, which are often unnatural. For example, "There are perfumes fresh as the bodies of children, clear as obes, green as the fields, and there are others, corrupt, rich and triumphant, possessing the expanse of infinite things, such as amber and musk, benzoin and incense."

Two other adjectives of smell are mentioned, for they are in common use, viz., sweet and sour. Properly speaking, these are adjectives for taste, and their usage in relation to smell may be metaphorical. The human mind, however, does not naturally distinguish taste and flavor, and if the odor is sufficiently concentrated to affect the sense of taste the mind may refer the taste sensation to that of smell. For a similar reason it is possible to describe smells as "bitter" or "salt." Often, however, a "sweet" smell means a pleasant smell, and a "sour" smell an unpleasant one.

(2) When the new cortex superseded the old, the sense of smell was dominated by the other senses. As a result, smells have no intellectual value, but their emotional power still remains high. The olfactory responses of attraction are appetizing, delightful, fragrant, sweet, etc.; those denoting repulsion are such as sickening, horrible, rotten, stinking.

(3) The individual is aware of the concentration of an odor—that is, of the intensity of stimulus. Here it again becomes necessary to use metaphorical terms, such as heavy, strong, weak or faint. This relative concentration of the odor is valuable in the animal kingdom in a spatial or directional way, a strong smell indicating that the object producing the odor is in close proximity, a faint smell indicating distance.

When the image of an object or its qualities is represented in the mind by a symbolic formulation, further mental association in connection with the object tends to cease, if the symbolic formulation comes as the solution of the problem. Every physician while examining a patient is aware of the number of images with which his consciousness is dealing, and of the activity of his mental associations. But these cease once he has succeeded in diagnosing and giving a name to his patient's condition. If a

number of mental images can be formulated under a name or symbol, many tedious mental processes are thus avoided. Similarly, when we have located a particular smell, such as that from gasoline, we have at hand a ready symbol with which to describe it; or, encountering the odor, we know it is gasoline and think no more about it. Extensive mental associations are not required to take place unless the odor of gasoline were in some unaccustomed place—e. g., in our food. But in the case of an odor which has been met before but has not been located, the re-encountering of this odor recalls a variety of images which were associated with the previous environment. The marked associative power of smells is a corollary to the low integration of olfactory impulses (Halliday). This, then, is the anatomic explanation for the lack of an olfactory nomenclature.

The following explanation is in direct opposition with the foregoing theory.⁶² Speech itself serves primarily as a substitute response for more extensive somatic responses. The same substitute response may serve as readily for the somatic response to an olfactory stimulus as for the somatic response to a visual stimulus.

1. Visual stimulus—motion—speech. (Descriptive of motion.) Conditioning takes place and we have—visual stimulation—speech.

2. Olfactory stimulus—motion—speech. (Descriptive of motion.) Conditioning takes place and we have—olfactory stimulation—speech.

The determining factor is the response for which it serves as substitute, not the stimulus which sets it off. A nomenclature for odors should therefore require no different anatomic mechanism than now exists whereby an odor may set off an extensive somatic response or its substitute verbal response—e. g., "Get that thing out of here" may be set off by the sight of a dead cat on the hearth rug or the odor of a dead cat in the wall. In either event it is a substitute response for toilsome contractions of many muscles.

The question of nomenclature is in effect one of vocabulary. Vocabularies develop to meet the social need of sharing ex-

perience by means of some common and convenient symbol. That we have no nomenclature for smell merely indicates no concourse of people has found its commerce, comfort, pleasure or safety suffering because of inability to call odors by names of their own. New vocabularies are arising daily, and should a social need appear for one which would accurately designate olfactory sensory qualities it seems natural to suppose the present anatomic mechanism of the brain would serve.

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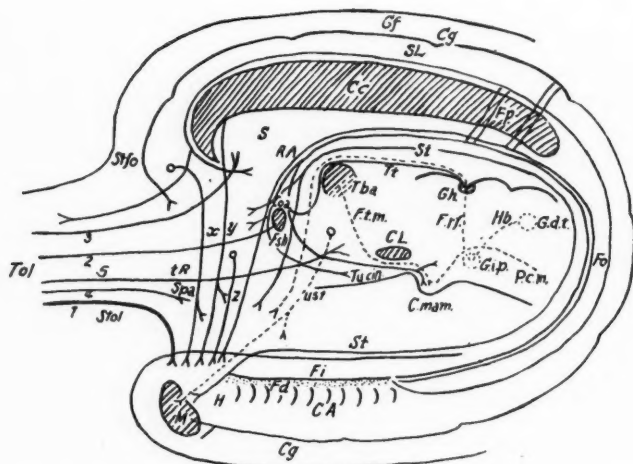


Illustration 1.—The schematic drawing (after Brunner) of the intracerebral communications of the olfactory nerve in man. The projection fibers are represented by the lighter colored lines. The association fibers are in black. The subcortical tracts are represented by broken lines.

M., nucleus amygdalae; H., gyrus hippocampi; F. d., fascia dentata; F. i., fimbria; C. A., cornu ammonis; C. g., cingulum; F. o., fornix; C. c., corpus callosum; F. p., fibrae perforantes; F. s. L., Striae Lancisii; G. f., gyrus fornicatus; St. Fo., anterior end of the Gyr. fornicatus; T. ol., tractus olfactorius; St. ol., stria olfactoria lateralis; F. p. a., substantia perforata anterior; R. t. R., deep olfactory tract; X., communication fibers between the Gyr. fornicatus and the Gyr. hippocampus; Y., communicating fibers between the corpus callosum (cortex ?) and the Gyr. hippocampus; Z., communicating fibers between the Gyr. hippocampus and the septum pellucidum; S., Septum pellucidum; R. A., olfactory bundle of Ammons horn; Co. A., anterior commissure; F. s. h., fibrae septo-hypothalamicae; V. S. T., ventral stalk of the thalamus; St., stria terminalis; Tu. cin., tubercinerum; C. L., corpus luyssii; Tha., frontal stalk of the thalamus; C. Mam., Copus mammillare; G. d. t., ganglion dorsale tegmenti; G. h., ganglion habenulae; G. i. p., ganglion interpedunculare; F. t. m. F., thalamo-mammilaris; T. t., thalma thalami; F. r. f., fasciculus retroflexus; P. c. m., pedunculus corpus mammillaris; H. b., tract from the ganglion interpedunculare.

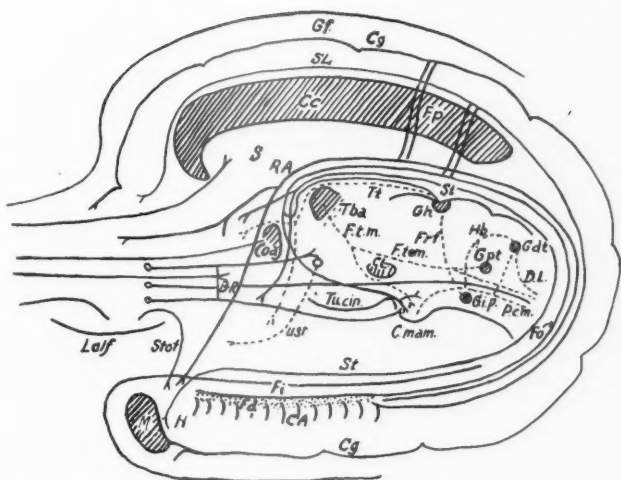


Illustration 2. Schematic drawing of the intracerebral communications in macroscopic animals. The same characters are used in both illustrations. L. olf., lobus olfactorius; B. R., basillar longitudinal bundle; F. tem. F., tegmento-mammillaries; G. p. T., gangl. profundum tegmenti; D. L., dorsal longitudinal bundle.

XLII.

MENINGITIS DEPENDENT UPON CLOSED ETHMOIDITIS: REPORT OF A CASE WITH A PLEA FOR ROUTINE AUTOPSY PROTOCOLS.

O. C. RISCH, M. D.,

NEW YORK.

The report of this case was prompted by a paper presented by the late Dr. H. W. Loeb, of St. Louis, before the American Laryngological, Rhinological and Otological Society, in May, 1923. He reported 332 fatalities following nose and throat operations. In his grouping, meningitis caused 125 deaths, thus proving this complication to be, by far, the most common cause. Autopsies were reported in but 9 of the 125 meningitis cases. The apparent etiologic factor in 7 of these cases was fracture of the cribriform plate. There was no record of the cause of the other 2 cases. The following year he reported 112 additional cases, 44 of which developed meningitis, and emphasized the necessity for autopsies. To quote him, "The study of these cases has served to strengthen the views expressed in my previous paper and impels me to urge all who meet with these unfortunate experiences to insist upon autopsies and complete autopsy protocols, to the end that we may have a better understanding of the processes involved and better means of combating them."

In City Hospital we had been very fortunate in obtaining autopsies. In 1930 these totaled 46.5 per cent.

The following case* illustrates the importance of autopsy protocols: The patient (M. H., female, age 30) complained of frontal headaches, especially on the right side, occurring intermittently over a period of several months; also of difficulty in breathing. Examination revealed an S-shaped deviation of the septum with a high deviation toward the right. There was no history of dis-

*From the otolaryngological service of Dr. Daniel S. Dougherty, City Hospital, Welfare Island, New York City.

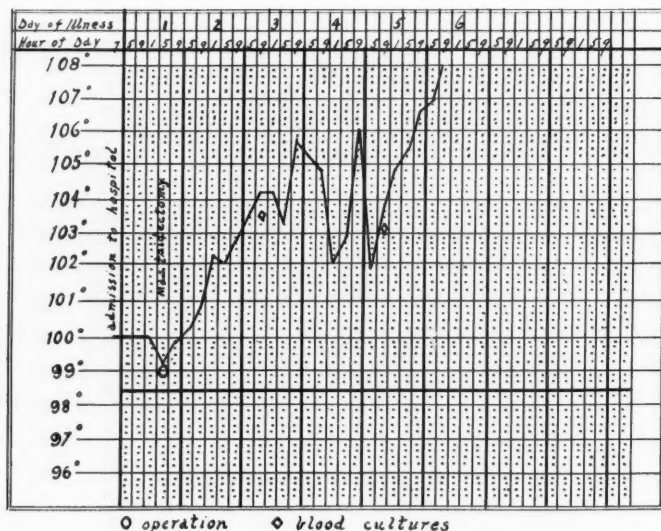
charge nor was there any present at the time of examination. The turbinates appeared normal except for compensatory hypertrophy.

A submucous resection was done, at which time the tip of the nose, which was extremely long, with a decided downward dipping, was shortened and elevated, the fossæ being lightly packed for twenty-four hours. No untoward changes occurred on the second day but an acute follicular tonsillitis developed on the third day, and an acute otitis media on the right side on the fourth day. The membrana tympani was incised. Symptoms of an acute mastoiditis developed and she was sent to the hospital.

On admission, the general physical examination was negative, except for a subacute pharyngitis. There was tenderness on pressure and edema over the tip of the right mastoid, narrowing of the external auditory canal and sagging of its posterior superior wall. Temperature 100° F. Blood count: red blood cells 4,500,000; leucocytes, 12,000, with 78 per cent polymorphonuclears. Roentgenogram showed infiltration of the right mastoid cells with destruction of the trabeculæ. The tentative diagnosis was acute otitis media and acute mastoiditis of the right side.

At operation the usual procedure for a simple mastoid was followed. The cells were found to be filled with a moderately thick purulent exudate, of which a specimen was taken for examination and culture. There was considerable destruction of the trabeculæ. An area of the sinus plate about one-quarter of an inch in diameter was removed. The sinus was apparently normal and the tegmen tympani was intact.

The day following the operation the temperature rose to 102.5° F. (see chart). The following morning the patient complained of weakness and pains in her legs. Examination showed rigidity of the neck with Kernig's sign present on the right side. The temperature was 104.4° F. Blood culture was taken (no growth). Lumbar puncture showed spinal fluid under markedly increased pressure; of a pearly turbidity with cells numbering 1200; globulin, 3 plus; sugar plus. Later in the day the lumbar puncture was repeated and 15 cc. of fluid was removed. Antistreptococcus



serum, 5 cc., was injected into the canal. Owing to resistance no more was injected into the spinal canal but 22 cc. of the same serum was injected into the median basilic vein of the left arm.

On the third day after operation the temperature was 105° F., the pulse 114. There was no rigidity of the neck or spasticity, and the patient appeared more cheerful. A spinal puncture was performed and 80 cc. of fluid was removed. The pressure had diminished and 50 cc. of antistreptococcus serum was injected into the canal and 25 cc. was given intravenously. The fluid showed 3000 cells; globulin, 2 plus; sugar negative. The spinal tap was repeated later in the day, at which time 40 cc. was removed and 25 cc. of the serum injected. Examination revealed rigidity of the neck, spontaneous nystagmus in all planes and a bilateral Kernig's sign.

On the fourth day the patient became comatose. The temperature was 105° F., pulse weak, respirations shallow. There was projectile vomiting and increased rigidity as the medullary syndrome gradually developed. A spinal tap showed 2700 cells with

96 per cent polymorphonuclears. Streptococci were found in a centrifuged specimen.

The following day the temperature rose to 108° F., respirations 32 and the patient died.

Diagnosis: Acute streptococcus meningitis secondary to mastoiditis.

AUTOPSY PROTOCOL.

The organs showed the result of an acute septic infection. The tegmen tympanum was intact. A small section of the right sinus plate was missing. Both inner ears were negative. The leptomeninges over the *left* temporal lobe and the basilar meninges were coated with a purulent exudate. This extended anteriorly, the involvement narrowing down to the width of 1 cc. at the sella turcica and extending anteriorly to the cribriform plate of the right side. The right ethmoid sinuses were filled with pus, the middle being most involved. The frontal sinuses were negative as were the maxillary and sphenoid.

The longitudinal, petrosal and transverse sinuses contained postmortem clot. No thrombi were present.

Diagnosis: Suppurative meningitis (nonhemolytic streptococcus) secondary to a closed ethmoiditis. Recent nasal plastic and submucous resection; right mastoidectomy.

INTERPRETATION OF THE CLINICAL COURSE.

A chief complaint of frontal headache of several months' duration with obstructed nasal breathing. There had been no nasal discharge. Examination showed a high deviated septum with no discharge above or below the middle turbinate. The history of the headache did not emphasize the element of persistency. A roentgenogram did not seem to be indicated. The septum was removed, a plastic operation was done and the nose was lightly packed.

When symptoms of acute mastoiditis developed following the tonsillitis and otitis media, a roentgenogram confirmed the diagnosis and a specimen taken at operation showed streptococci. When meningitis developed it appeared to be referable to the mastoid infection.

The autopsy, however, proved that the meningitis was due to the presence of a suppurative ethmoiditis, a sequence of events that could occur from (1) the presence of a latent or closed ethmoiditis at the time of operation excited to activity by lowered resistance or (2) infection of the ethmoid cells because of packing after a submucous resection. The nose, however, was only lightly packed. Conclusion: Exacerbation of a latent ethmoiditis, following acute follicular tonsillitis, otitis media and mastoiditis, causing meningitis.

Current literature contains reports of a number of cases of similar nature.

Gerber reports a case of a woman, thirty-two years of age, who had an attack resembling influenza which did not confine her to bed. On the eighth day she had marked headache and developed a discharging left ear. She became bedridden and went into coma. She showed symptoms of meningitis. Lumbar puncture showed cloudy fluid with pneumococci found on culture. Mastoid operation was performed but no infection was found. Dura, exposed, was negative. She died on the eleventh day. Postmortem proved the meningitis secondary to an ethmoiditis on the right side.

Schmiegelow cites the case of a girl, fourteen years of age. She was ill for two days with headache, restlessness and delirium. Showed typical symptoms of meningeal irritation. Nothing abnormal was found in the nose, throat or ears. Spinal fluid showed pneumococci. The patient died in two days. Postmortem proved the patient to have an ethmoiditis with extension through the cribriform plate.

Knapp reports a case of closed ethmoiditis with no discharge from the nose prior or subsequent to operation. This case, however, showed a swelling over the left eye. She was operated upon for empyema of frontal and ethmoid cells but died of meningitis. Autopsy showed an erosion through the cribriform plate.

A case of interest is that reported by Harris, in 1918. In the course of routine examination a student officer admitted that he had difficulty in breathing. An obstructing growth on the right side was found. A cystic middle turbinate was removed. Convalescence was uneventful. Five days later he developed menin-

gitis and died. Postmortem revealed necrotic cells with a direct communication between the cystic turbinate and the brain through what appeared to be a smooth perforation resulting from an injury to the nose twelve years earlier. The operation upon the middle turbinate, slight as it was, served as the exciting cause.

Watson cites a case in which the right antrum had been explored a few months prior to an operation on the left antrum. The latter contained pus. Two days later the patient developed symptoms of meningitis and died. Autopsy revealed an acute purulent meningitis originating from the area of erosion in the roof over the middle ethmoid cells on the right side. The noteworthy feature of this case is that the meningitis was associated with erosion on the right side, the side opposite to the operation on the antrum. It is also to be remembered that the other antrum was operated upon a few months earlier with negative findings.

These case reports prompt the discussion of what we understand by closed ethmoiditis. Hajek classifies ethmoiditis in the ratio of 1 open to 2 closed. The open form causes little difficulty for diagnosis, but it is usually the latter which gives the surgeon undue trouble and anxiety. In open empyema of the ethmoid cells pus flows into the nasal cavity, whereas in closed empyema it is blocked and, by pressure upon the walls, soon leads to dilatation or periostitic changes of the bony wall. These may be relative or absolute, temporary or constant. As a rule, closed ethmoiditis manifests itself as suppuration in a bullous-formed middle turbinate, (2) suppuration in a misplaced ethmoid cell, or (3) suppuration in the bulla ethmoidalis. In these cases rhinoscopic examination shows a tumor-like middle turbinate and should be recognized by the rhinologist. It cannot be denied, however, that at times no pathologic changes are found in the nose. I believe that the cases mentioned are of this character.

Skullern gives four possible terminations of closed ethmoiditis: (1) Subsidence of inflammation and absorption of the products; (2) secretion that continues up to a certain stage and then remains dormant; (3) continued secretion of inflammatory products and ultimate rupture of the walls; (4) the formation of a mucocele. The course of the infection depends on the virulence of the invading organism and the resistance of the host.

CONCLUSION.

1. The importance of excluding the presence of closed ethmoiditis in meningitis.
2. The advisability of roentgenograms before nasal operations are attempted.
3. A plea is made for autopsy protocols on all fatalities so that we may improve our knowledge in rhinology and thereby prevent serious consequences from relatively simple operations.

104 EAST FORTIETH STREET.

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XLIII.

SINUSITIS IN CHILDREN.*

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Infection in the paranasal sinuses, as in any other parts of the body, is the result of a relative disproportion between body resistance and virulence of the infecting organisms. The local factor in the production of sinusitis is obstruction to the ostia of the sinuses. This obstruction again may be due to local mechanical conditions, or the result of mucous membrane thickening. Recent investigation and literature have placed much emphasis upon disturbance of general metabolic processes, with resulting mucous membrane thickening, in the etiology of sinusitis. The chief causative factors discussed are: endocrine imbalance, vitamin deficiency, and allergy. Some have attempted to explain sinusitis as a result of these factors and that its prevention or cure depends upon proper endocrine balance, sufficient vitamin content in our food and medication, or desensitization from the protein to which we are sensitive.

There is little if any doubt that these factors, and probably others, have much to do with the sinus problem and are the primary reason for infection taking place in an undetermined number of cases. There is, however, a decided question as to whether we are ready to say that most sinus infections are not due primarily to the direct effect of bacterial invasion—as the result of acute colds, measles, scarlet fever, influenza or repeated infection from contact with one who has chronic nasal infection. In short, is the altered metabolism of the individual or the bacterial factor the major one? We seem at present in danger of having the pendulum swing too far toward the idea that vitamin deficiency or allergy is primary and always of paramount importance.

*Read before the Indianapolis Medical Society, April 7, 1931.

†Department of Otolaryngology, Indiana University School of Medicine.

It is important that we determine as accurately as possible the predominating factor in any given case, particularly in children, as the treatment should differ to some extent in the extremes of the two types. Any healthy child who develops empyema of the sinuses from measles may have a resulting altered metabolism with protein sensitization if temporizing methods are used and infection continues. On the other hand, the true allergic will get very little relief from surgical measures alone.

Influenza, or la grippe, appeared as a pandemic in 1889. Accompanying and following this many cases of sinusitis appeared. This was the first time medical attention had been centered upon the paranasal sinuses. This attention was limited principally to adults until more recent years, when the work of Coffin, Mosher, Coakley, Wood, Myles, Dean, Emil Mayer and others demonstrated that children, also, are subject to sinus infections. It is now believed that sinusitis is relatively frequent between birth and the age of twelve years, and should be considered a major pediatric problem. Francis P. Emerson of Boston states that it is probably as frequent in children as in adults. Watson-Williams reports, from the British Royal Infirmary, that 20 per cent of children who require tonsil and adenoid removal have one or both antra definitely infected. Dean, in 234 cases where routine operations for diseased tonsils and adenoid were done, cultured and irrigated the maxillary sinuses and found 15 per cent with chronic empyema of one or both. It is probable the incidence of sinusitis varies in different localities, and it is quite certain that it varies with seasonal changes.

We have all been impressed with the frequency of sinusitis in children, and among other things an attempt has been made to determine what percentage of the children entering the James Whitcomb Riley Hospital have sinus infection. These investigations have been carried out at intervals since 1925. The plan followed by others has been to irrigate all maxillary sinuses in a given number of routine tonsil and adenoid cases. We have chosen to investigate only those which show evidence of sinusitis after a careful history, nasopharyngeal examination, transillumination, and in more than 80 per cent, X-ray of the sinuses. Only those showing pus or cloudy fluid with positive bacterial cultures have been re-

corded as diseased sinuses. During June and July, 1927, 96 routine admissions were studied, in which 12 per cent were found to have pus in one or both maxillary sinuses. During the twelve months from July, 1928, to July, 1929, 328 children were examined routinely, with clinical and later pus or bacteriologic evidence of sinus infection found in 14.2 per cent. In 231 of these (424 in the two groups) there was less than 1 per cent variance between clinical and X-ray findings in suspected cases. No attempt was made to select any type of case for these investigations. They included pyelitis cases, cardiacs, epileptics, orthopedic cases, and many who were admitted only for tonsil and adenoid removal. What number of cases may have been overlooked, we have no way of knowing, but these findings stimulated a more careful search for sinus disease in all routine examinations.

During August and September, 1930, we decided to select only those cases referred to the hospital for tonsil and adenoid removal without other diagnosis. All known sinus cases or allergics were eliminated from this group. There were 211 children admitted during these two months, for tonsil and adenoid removals only, who were examined for evidence of sinusitis with positive clinical findings and pus in one or both maxillary sinuses in 30. X-ray evidence was positive in 28 of these 30 cases. The reason for tabulating findings in the maxillary sinuses only is because of the comparative ease with which definite evidence of suppuration can be demonstrated. There is clinical and X-ray evidence of involvement of other sinuses, particularly the ethmoids, in most of these cases, and it is my belief that ethmoiditis is often primary and frequently remains as a latent infection after the maxillaries have received attention. The outstanding observation in the history of each of these groups is that 60 per cent gave a history of contact, some member of the family having catarrh, frequent colds, bronchitis or sinus disease. Many date their trouble from the acute exanthemata or attacks of tonsillitis. It is generally believed by investigators in this field, such as Coffin, Dean and others, that the chronically infected adenoid and tonsils are responsible for many of the sinus infections occurring. We have repeatedly demonstrated the fact that it is difficult, if not im-

possible, to cure sinusitis with infected and obstructive adenoid and tonsils present. The child who has more ear and tracheo-bronchial infection after tonsil and adenoid removal has always been a problem. In all of these cases seen we have been able to demonstrate serious sinus involvement, and believe that if the sinusitis is diagnosed and relieved these exaggerated symptoms will rarely if ever occur.

The chief complaints of the cases having sinus infection in the last group were stuffy noses with frequent or continuous discharge, lack of energy with inability to progress in school, poor appetite and inability to gain weight, attacks of bronchitis and suppurating ears. As a matter of fact, the symptom complex was practically what we have been accustomed to consider that of tonsil and adenoid infection and hypertrophy.

The rhinoscopic examination during the winter weather almost invariably shows swelling of the nasal mucosa with nasopharyngeal irritation and discharge. Pus is frequently found in the nasal passages or nasopharynx or can be demonstrated by using suction. During the summer months, however, when infection is quiescent, these signs may be very slight or absent. Transillumination has been of great value in children over four years of age. We attempt to regulate the light according to the size, bony development and natural pigmentation of the child, and find it indispensable in detecting infected sinuses at examination. X-ray findings of the maxillary sinuses have varied from the clinical findings in less than 2 per cent in more than 300 cases studied. X-ray findings of the posterior sinuses, while indispensable, have been less satisfactory, frequently because of lack of co-operation of the child. Headache or pain is a rare complaint except during an acute infection, when there may be a throbbing pain on lowering the head. Intermittent temperature of one-half to one degree over a long period of time is common in the sub-acute or chronic case and occurs during periods of activity. Temperatures of 103 to 104 degrees may occur with acute attacks, and we have seen a drop of three degrees following the evacuation of 2 cc. to 3 cc. of pus from a maxillary sinus by using suction.

The blood picture, except in acute cases, shows moderate increase in the white cell count with a lowered hemoglobin and red cell count. While our blood chemistry work has been limited in comparison to the number of cases observed, there has been no marked deviation from the normal.

Almost every pus-producing organism has been found in the smears, and it is evident that no single known organism is a specific causative factor. Of the last series of 211 cases, in August and September, in only two of the thirty diagnosed sinusitis was the streptococcus found; one hemolytic. In nine of the thirty a hemolytic staphylococcus aureus was present. This organism usually portends a delayed convalescence.

The treatment of sinusitis in children must be extremely variable and frequently prolonged, depending upon the pathology present, the virulence of the infection and the nature of the complicating diseases. Dean believes that 80 per cent recover without further treatment if infected tonsils and adenoid are removed. This is probably true in the average private practice, where causative factors, such as diseased tonsils and adenoid, are removed before massive chronic pathology is present in the sinuses, and where parental co-operation as to diet, hygiene, etc., may be had. We have not seen this happy result in the charity clinic, where treatment is delayed and the home environment is less satisfactory.

Very early we established a rule that all cases showing evidence of sinusitis should have a needle inserted into the antrum and cultures taken. We then irrigated the sinus with normal saline solution and attempted to determine the amount of obstruction present in the sinus ostium and observed the character of the pus, if present. If only moderate obstruction was present and no general condition demanding immediate relief from infection existed no further surgery was done. Few cases in private practice require more than irrigation when follow-up treatment is possible. When obstruction was marked, with frank pus, or if a grave complicating disease existed, openings were made with a maxillary rasp. These openings we found were inadequate and soon closed. Following this for several months

we inserted an especially made rubber tube into the maxillary opening, allowing the proximal end to extend through the nares so that aeration and drainage might continue, and to permit of frequent irrigation. Our results were unsatisfactory on account of the irritation by the tube. For the past three years, in all cases requiring more than irrigation, we have made a large maxillary window under the inferior turbinate as far back as possible with clean biting punch forceps, care being taken not to injure the anterior nasal structures. This method is proving satisfactory, as evidenced by clinical results and numerous X-ray studies, three, six, nine and twelve months after operation. It is well, however, to bear in mind the fact that children as young as eight or ten years may have chronic sinus pathology in every way comparable to that found in adults. Selection of these cases demands the same intensive observation and study as adults. Lipiodol studies, particularly of the maxillary sinuses, are of great value. (Figs. 1, 2 and 3.) Microscopic study of tissues removed from these children shows all stages of pathologic changes, including simple inflammatory reaction, edema and polyps, abscess formation, marked fibrosis with arterial occlusion, and destructive changes in the bony walls. (Figs. 4, 5, 6, 7, 8, 9, 10.) One child, aged nine, with subacute bacterial endocarditis and a streptococcic blood stream infection, had markedly thickened maxillary mucosa with an abscess at the base from which streptococcus viridans was recovered. This child improved rapidly after radical surgery, and after one and a half years is clinically well. Radical procedures have been done in less than 3 per cent of Riley Hospital cases.

Local treatment and observation for a satisfactory result must be continued over a period from a few weeks to two or three years, depending upon the pathology present. The cure is often more apparent than real, especially in warm seasons. Drainage and aeration of the sinuses must be maintained long after symptoms have subsided. This is probably best done by suction drainage. Well directed home medication, such as ephedrin in the nose, is valuable at times, but the indiscriminate use of nose drops, particularly in acute infections, is daily doing harm and bringing valuable therapeutic agents and measures into disrepute.

General treatment and direction is indispensable to a cure of sinusitis in children. Sufficient evidence is at hand that food values and vitamin content have a profound effect upon the mucous membranes of the body. Toxic proteins from a disturbed gastrointestinal tract may prevent progress. Regulation of exercise is very important. Few of these cases do well if permitted to remain active all day. Periods of complete bed rest must be insisted upon daily, the length of time depending upon the case.

It is highly important that these children be protected as far as possible from acute infection. Warm, fresh air is the ideal atmospheric condition which should obtain both in the day and during sleeping hours.

Ultraviolet radiation is of considerable value when applied generally during the winter months. Its local application gives little if any results.

In conclusion, I wish to emphasize the fact that sinusitis is common during childhood and that a permanent cure depends upon early recognition and a more or less prolonged, well-directed regime.

505 HUME-MANSUR BLDG.

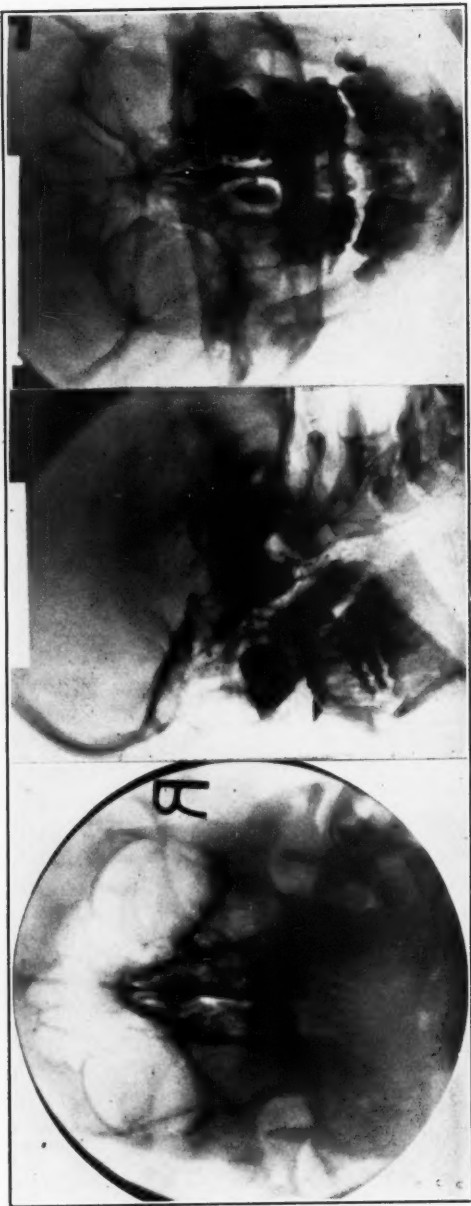


Fig. 1.

Fig. 2.

Fig. 3.

Figs. 1, 2, 3. Primary film and lipiodol visualization of left maxillary sinus. Child, 8 years, continued with attacks of bronchitis and pyelitis for one year, during which time treatment and maxillary windows failed to cure the maxillary infections. Bilateral Caldwell-Luc operation, with recovery. Microphotographs 8 and 9 from this case.

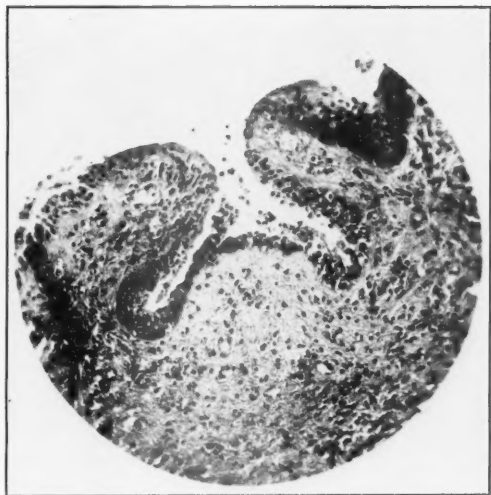


Fig. 4.

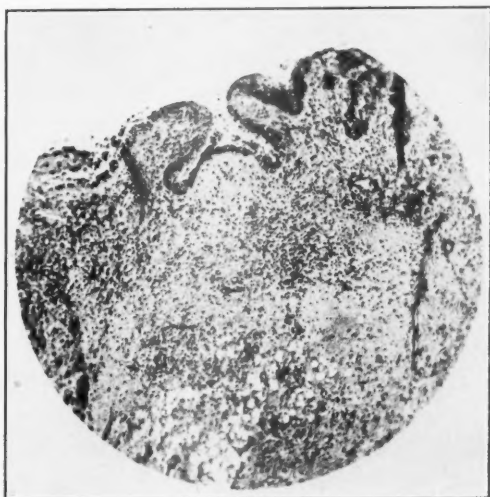


Fig. 5.

Figs. 4 and 5. Epithelial destruction, marked thickening and round-cell infiltration of subepithelial structures with fibrosis and arterial occlusion at the base. Fig. 10 from same specimen near bony attachment. Child, 11 years old.

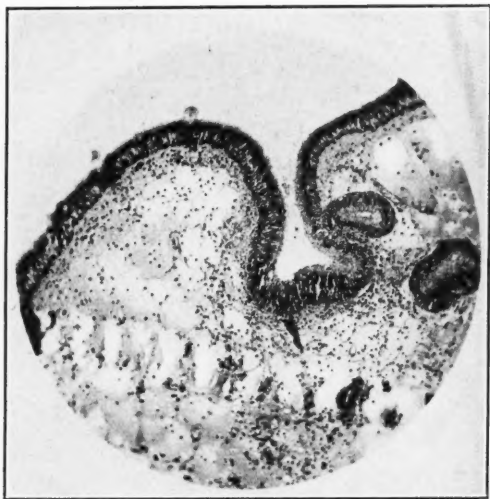


Fig. 6. Marked edema and some round-cell infiltration. Mucosa contained a cystic abscess from which streptococcus viridans was recovered. Case of streptococcal bacterial endocarditis.

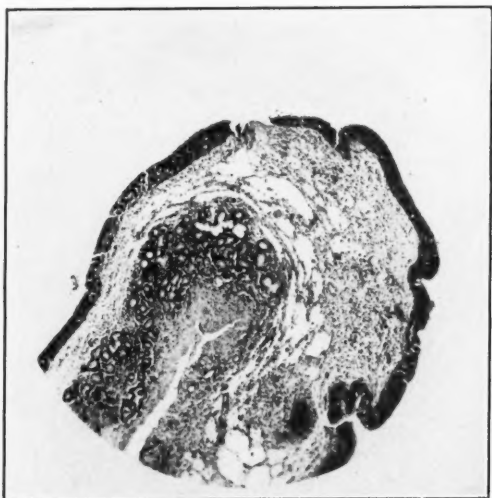


Fig. 7. Edema, round-cell infiltration, with tendency to polyp formation. Child, 10 years old.



Fig. 8. Marked fibrous change in mucous membrane, with partial fibrous occlusion of artery, A.



Fig. 9. Same specimen as 8, showing fibrous thickening of arterial wall.

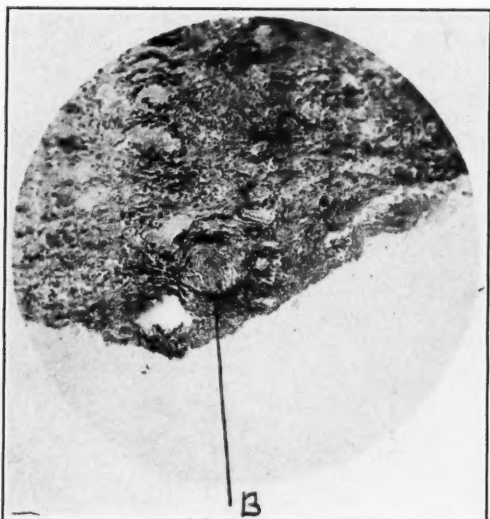


Fig. 10. Specimen near the bony attachment of the maxillary sinus, from a child 9 years old, with beginning bronchiectasis, showing round-cell infiltration, necrotic areas, fibrosis and complete arterial occlusion, B.

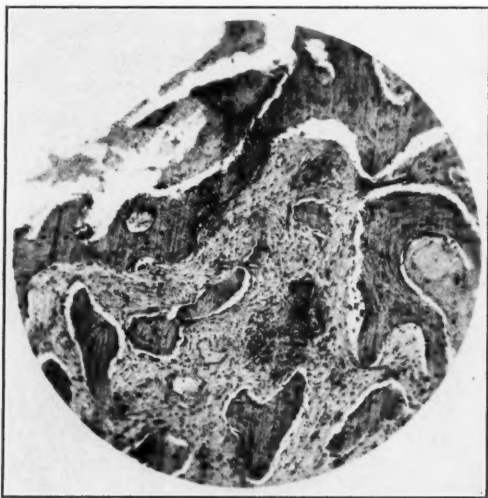


Fig. 11. Specimen from anterior bony wall of maxillary sinus in canine fossae (same case from which specimen 10 was removed), showing osteitis, with bone absorption, formation of fibrous tissue and round-cell infiltration.

XLIV.

A NEW CONCEPTION OF THE ETIOLOGY OF
ATROPHIC RHINITIS.*

HARRY L. POLLOCK, M. D.,

CHICAGO.

For many years rhinologists have attempted to solve the problem of the etiology of atrophic rhinitis. For twenty years I have been interested in this condition, not so much from the etiologic point of view as from the point of view of prevention and alleviation. Recently an article has appeared describing a new pathologic condition which warrants serious consideration.

In 1923, I presented a paper before this society—"Intraseptal Implantation in Atrophic Rhinitis"—in which were enumerated the various theories of its etiology that had heretofore appeared in the literature. I believe that a majority of rhinologists have accepted two theories: (1) that of Grünwald, who claimed that this disease was secondary to chronic sinus infection and that every case of ozena is associated with suppurative sinusitis; and (2) that of Zaufal and Hopman, which brings forth the idea of abnormal patulency of the facial bones which makes the air spaces in the nasal chambers much larger than those found in normal individuals. The fetor characteristic of this condition is unquestionably produced by the action of saphrophytic organisms developing in a fertile, warm, moist media of the nasal cavities. The mere presence of Abel's bacillus or Perez diplobacillus fetidus does not signify that they bear any etiologic relation to the atrophy, but rather to the production of decomposition with resultant fetor. Zaufal, many years ago, explained the formation of crusts as being due to the drying up of the water portion of secretions by an abnormal inrush of air, leaving the solid contents in the form of crusts. The aforementioned explanations of the clinical findings in this disease, namely, suppurative sinus

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disease, fetor and crusting, have been generally accepted and we are now confronted with the problem of explaining the most important pathologic condition, viz., atrophy of the tissues of the nose.

In the February, 1929, issue of the *Zeitschrift für Hals, Nasen und Ohrenheilkunde*, there appeared an article from the pen of Dr. Klaus Vogel of Berlin, entitled "Histopathological Findings in the Sphenopalatine Ganglion with Special Reference to Atrophic Rhinitis." The pathologic findings to be described in this paper are taken entirely from his article with my own comments on his conclusions. I shall omit the technical portions regarding fixing, cutting and staining of sections, except where some interpretation is required.

Some time ago, Dr. Vogel had an opportunity of obtaining the sphenopalatine, gasserian, ciliary, geniculate and jugular ganglia of a young woman who had died suddenly under local anesthetic just prior to a surgical operation and who, during her lifetime, was afflicted with ozena. The sphenopalatine ganglion showed atrophy and degeneration of the ganglion cells with increase of the connective tissue with round cell infiltration, while the other ganglia were normal or very slightly changed. His pathologic report of the sphenopalatine ganglion in this case is as follows: A marked increase of connective tissue surrounding the ganglion and, between the ganglionic cells, the latter seem to be almost submerged in connective tissue. The cells of the ganglion capsule embrace those ganglionic cells that are dark and seem to be lying in the recesses of the former. The cells of the capsule are poorly stained, probably due to the long process of decalcification, and are considerably outnumbered by the cells that contain long and slender connective tissue nuclei. Most of the capsules of the ganglionic cells have lost their round shape, have become considerably smaller and seem to crowd in the ganglionic cells lying in them. The ganglionic cells are no longer round. They are small, oblong or angular and show ragged edges and often take on a dark stain. Individual Nissl bodies can no longer be recognized. Other cells are markedly swollen. Scarcely a single cell is entirely normal. The nuclei are small,

dark, almost black, angular, eccentrically located, and do not take the stain as well as those of the normal ganglionic cells stained the same way for comparison. However, there are also some hugely distended nuclei whose structure is more distinct than that of a normal nuclei. These changes are equally distributed over the entire ganglion. Aside from these changes in the ganglion the section shows distinct round cell infiltration near the small veins in the area that surrounds the ganglion. The infiltrations seem to be located mainly around those veins that enter through the sphenopalatine foramen. The round cell infiltration follows the course of the infraorbital nerve toward the foramen rotundum, where it gradually ceases. In the orbita none are present. Toward the mucous membrane of the nose the infiltrations are more frequent and larger. In the ganglion itself and in the nerve trunks belonging to it this round cell infiltration is found along the course of the blood vessels. It is composed of some polymorphonuclear leucocytes but mainly of lymphocytes and also some round cells with light nuclei. A comparison of these findings with a normal sphenopalatine ganglion shows the pathology very distinctly. The author then describes the sphenopalatine ganglion of a child, six months of age, who had died of a tuberculous meningitis. This specimen showed the least change of any among sixty ganglia examined. He states: "Everywhere one sees round ganglionic cells with clear protoplasm and filled with Nissl bodies. The edges are smooth and the cells fill the endothelial capsule. The nuclei are round, clear and bulbous, lying centrally with sharply defined nuclear membrane. The chromatine network is plainly visible. The nucleoli are pointed and dark and often contain a central vacuole, occasionally cells with double nuclei are seen. Between the ganglionic cells very little connective tissue is found and round cell infiltration is seldom noted." Vogel obtained specimens from the living in ten other cases of ozena, one in luetic ozena and one in simple atrophy without ozena. In the above mentioned cases he did a Halle-Seufert operation and then incidentally removed one ganglion by doing a radical antrum operation with removal of the posterior wall. The technic of the removal of the ganglion is given in detail in his article, and I only mention it here so that anyone

interested may further investigate the same. The pathologic findings in all of these ozena cases were practically the same, namely, an atrophy of the entire ganglion. But it was quite different in the other two cases described—that is, in the syphilitic ozena and the simple atrophy, wherein the ganglia were found practically normal, although some slight changes were found. In the case of syphilitic ozena the amount of destruction, the fetor and crust formation were more extensive than in the cases of ozena described, but nevertheless, the ganglion was almost normal, a point to which I will draw further attention in my discussion. The examination of the gasserian, ciliary and jugular ganglia in the luetic ozena disclosed some signs of degeneration, but in no way so marked as was the sphenopalatine in the nonluetic ozena, nor could it be actually associated with the ozena.

The author concludes that owing to the atrophy of the sphenopalatine ganglion found in ozena, there must be some physiologic relation between the ganglion and the nose, but is not definitely committed as to which is the cause and which the effect, though he believes the degeneration of the ganglion is due to the ozena—i. e., an ascending degeneration of the nerves. That it is not a descending degeneration the author attributes to the fact that both the gasserian and geniculate are normal, hence the impossibility of a descending degeneration. That certain infectious, toxic or internal secretory diseases might attack and injure the sphenopalatine to the exclusion of the other ganglia is regarded by the author as possible but highly improbable. To this statement he brings evidence of the examination of fifty-one specimens brought to autopsy from acute infectious diseases of all descriptions in which he found pathologic changes in the sphenopalatine and other ganglia but none resembling the particular connective tissue degeneration found in ozena. Dr. Vogel presents six statements as evidence of the correctness of his conclusion that the etiology consists of an ascending degeneration of the nerves, leading to a subsequent degeneration of the ganglion. I am not at all convinced of the value of this evidence, feeling that the facts speak rather for a primary degeneration of the ganglion in atrophic rhinitis. In the following I present Dr. Vogel's contentions and my comments thereon:

Statement 1. The histologic picture does not speak against it.

Comment. This being negative proof, no reply is warranted.

Statement 2. The resection of the ganglion does not alleviate the ozena, which it should do were it the primary cause of the disease.

Comment. Resection of the ganglion could not cure the ozena, since atrophy of the nasal cavity has already occurred, and the fetor is due to the action of the putrefactive bacteria upon the secretions which have accumulated in the nose. Does it seem logical to suppose that the atrophic tissues would return to normal and the fetor disappear following the resection of the ganglion, whether same was primarily or secondarily affected?

Statement 3. The resection of the ganglion does not increase the symptoms already present, nor does it produce fetor in cases where this symptom had been previously absent. Author cites two cases: The first had atrophic rhinitis without odor; and nine months after resection of the ganglion fetor was still absent. The second was that of a healed out tertiary lues of the nose. Ganglion was resected, and four months later, at the time of writing, no fetor was present, although extensive destruction and crusts were present.

Comment. The foregoing does not prove that the degeneration of the ganglion is due to the atrophic rhinitis, nor does it prove anything else, for we know that not infrequently we encounter advanced cases of atrophic rhinitis in which the symptom of fetor has never been present. Therefore there can be no connection between the fetor and the removal of the ganglion, since fetor only occurs when the action of putrefactive bacteria is at work, and it is not a primary symptom of the disease.

Statement 4. Referring to Case 2 (tertiary syphilis), the author believes that at some later date fetor will be present, even though the resected ganglion proved normal. Were the ganglion the primary cause, degeneration of the ganglion would have been present at the time of resection.

Comment. In this case we are dealing with an entirely different entity—a case of syphilitic destruction, which bears no relation to the nonluetic type which is associated with a degenerated ganglion.

Statement 5. In cases of acute and chronic diseases of the nose and sinuses no pathologic changes were ever found in the ganglion.

Statement 6. In cases of infectious and noninfectious general conditions, no irreparable damage to the sphenopalatine ganglion was found which later in life caused degeneration of the sphenopalatine leading to a secondary ozena.

Comment on 5 and 6. We know that there are thousands of cases of acute and chronic sinus disease as well as patients suffering from general infections who never develop atrophic rhinitis, but, in my opinion, there must be other contributing factors necessary to bring about atrophic rhinitis, such as a hereditary tendency (for we know that often it is a familial disease) and an abnormal patulency of the nasal chambers.

The author raises the question of why we never get an atrophy of the mucous membrane of the hard and soft palate, which is supplied by the palatine major and minor nerves, if the sphenopalatine is the primary cause of the condition. The answer is rather simple if we study his article, published in the *Zeitschrift für Ohrenheilkunde*, in March, 1930, regarding the anatomy of the sphenopalatine ganglion. He proves microscopically that the palatine major nerves arise directly from the second branch of the trifacial without being broken up in the ganglion itself. A very small portion of the nerve arises from the ganglion, and the palatine minor nerve is derived both from the second branch of the fifth and from the ganglion.

The author concludes this portion of his article by making one statement which speaks emphatically against an ascending degeneration—that is, that in simple atrophy there is not so much new growth of connective tissue and subsequent shrinkage of the ganglionic cell as is found in ozena, and secondly, in luetic ozena there is still less change in the ganglion than found in simple atrophy. Vogel contends that if the disease were caused by an ascending degeneration the same changes would be found in all three conditions.

Recalling the pathologic report of Dr. Vogel, earlier in the paper, it will be noted that the degeneration affected only the sphenopalatine ganglion to the exclusion of the other ganglia.

This would naturally raise the question as to why this occurs. My reply would be that it is probably a selective action, which is as unexplainable as the selective action of other pathologic conditions such as occur in otosclerosis where only the bony labyrinth and footplate of the stapes are effected and no changes are found elsewhere.

My opinion is that the degeneration of the sphenopalatine ganglion in atrophic rhinitis, with or without ozena, as clearly described by Vogel, is that the suppurative sinus disease has a selective action on the ganglion in those individuals with a familial tendency to atrophic rhinitis where there is also present an abnormal patulency of the nasal chambers.

My conclusions are as follows:

1. In cases of atrophic rhinitis with ozena, certain definite pathologic changes in the sphenopalatine were found, as described by Vogel.
2. Similar degenerative changes of the sphenopalatine ganglion were not found in any other disease, local or general.
3. Similar degenerative changes were not found in any other ganglion in the presence of ozena.
4. No trophic changes were found in the area supplied by the palatine major and minor nerves, since the majority of fibers forming these nerves arise directly from the second branch of the fifth and only a minor portion actually arise in the ganglion itself.
5. Having found these pathologic changes only in the sphenopalatine in cases of ozena, is it not probable that we are dealing with a definite infection whose action is selective?
6. If the degeneration were an ascending one, we would surely expect to find the same degenerative process affecting the other ganglia associated with the sphenopalatine.
7. Definite evidence of round cell infiltration existed in the vessels and tissues adjacent to and in the ganglion in its branches. This infiltration was more prominent toward the mucous membrane of the nose. A fair number of polymorphonuclear leucocytes were in evidence in the aforementioned areas, thus definitely

establishing an infectious nature. Taking the other pathologic factors into consideration, the *modus operandi* of the development of atrophic rhinitis can reasonably be accepted as being the following: The primary stage is a sinusitis (which exists in all atrophic cases), with subsequent infection and degeneration of the ganglion and thence leading to a similar degenerative change in its nerve fibers which end in the nasal mucosa. As only a few atrophic cases result from nasal sinusitis, one must more or less assume the presence of predisposing factors, namely, hereditary tendency and abnormal patulency of the nasal cavities.

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A NEW HEADREST FOR MASTOID AND BRAIN SURGERY.

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Anyone who does mastoid surgery knows how difficult it is to keep the head in a proper position. Not only is this an annoyance to the surgeon, but the constant shifting of the relative positions is often confusing, and, in working about the sigmoid sinus or the dura, or in searching for a brain abscess, it is of the utmost importance that a fixed position be maintained. When sandbags and pillows are used a strain is often placed upon the sternocleidomastoid muscle, and the patient frequently complains bitterly of a very painful neck during the convalescence.

I have also found that considerable concussion may be produced in the brain when the head lies on a small area in apposition to the hard table. This was brought to my attention in a very striking manner by the postoperative shock which resulted after mastoidectomy upon a patient on whom I had operated for an infected, ruptured sigmoid sinus, following a skull fracture.¹

Following this unpleasant experience I set about to devise an instrument which would hold the head in a fixed position without strain upon the sternocleido muscles, that would relieve the *jar* that was produced by the gouge and mallet, and would permit an open surgical field.

With the assistance of Dr. Nelse F. Ockerblad, I devised the headset which is shown in the accompanying figures. This consists of a chuck, with four adjustable hand-shaped headpieces that are padded with thick soft rubber. The chuck is mounted upon a strong stand with a tripod base without rollers. The headset is firmly attached to the operating table by two clamps. The occipital headrest is interchangeable, which makes the proper position for the head when working on either the right or left side. There are four separate adjustable parts.

Fig. 1. (a) Screw wheel which adjusts the height of apparatus.
(b) Screw wheel adapting apparatus to different heights of operating table.

(c) Wheel clamp, fixing apparatus to table.

(d) Screw wheel which moves all of the chucks simultaneously.

(e) Wheel which adjusts the head-shaped rests to fit various shaped heads.

(f) Sponge rubber cushion lining each chuck.

(g) Grooved slots, just below the chuck, which permit tipping forward and backward so that the head need not be fixed in awkward positions. It is the proper adjustment of these grooved slots which relieves the tension upon the sternocleido muscle.

(h) Chuck slide socket adjustable simultaneously and separately.

Figs. 2 and 3 show the comfortable position for the patient's head.

I have used this instrument five years, and find that by keeping the head in a fixed position it shortens my operative time about ten minutes, and that my patient never complains of postoperative sore neck. In removing the bone preparatory for exploring for a brain abscess I find that there is much less concussion and the hazards of the operation are diminished.

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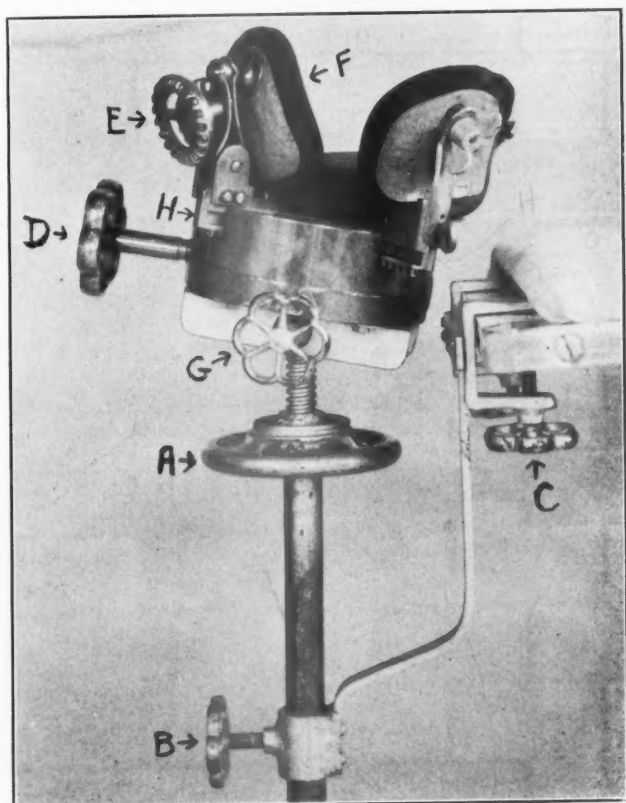


Fig. 1.

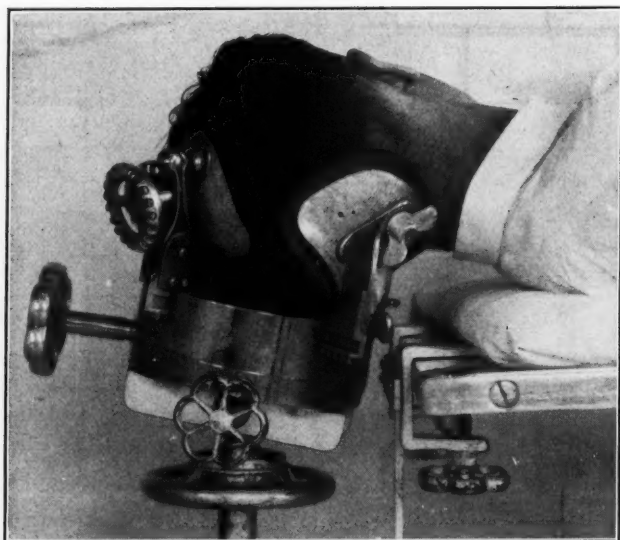


Fig. 2. Showing comfortable position of patient's head.



Fig. 3. Showing comfortable position of patient's head.

XLVI.

A NEW TECHNIC FOR THE REMOVAL OF THROMBI
FROM THE SIGMOID SINUS AND
JUGULAR BULB.

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Every otologist who has had any experience with thrombophlebitis of the sigmoid sinus and jugular bulb knows how difficult it is in certain cases to remove the thrombus and get free bleeding from either end. Failure to secure these results has always left me with the feeling that I have not completed my operation. To have opened the sigmoid and removed only a portion of the thrombus lying adjacent to the mastoid cells, offers but little benefit to the septic patient. The remaining infected plug, which has direct contact with the circulating blood stream, is the active focus of infection, and, if possible, should be completely removed. Not only does this focus continue to feed virulent bacteria into the blood stream, but it may, and frequently does, produce two serious intracranial complications, namely, diffuse meningitis and brain abscess.

The removal of the thrombus from the upper, or torcular, end may not be so difficult, as the bony covering of the sinus can be removed in this direction. Unfortunately, the extension of the thrombus upwards and backwards does not happen nearly so frequently as involvement downward into the jugular bulb. Even though the thrombus does extend back into the torcular end, the primary seat of the thrombus has usually been in the jugular bulb, and the operation is by no means complete when free bleeding is secured only from the upper end of the open sinus. Radical resection of the jugular bulb is a difficult surgical procedure, both for the surgeon as well as the patient, in that it risks injury to the facial nerve and extension of infection downward into the deep planes of the neck.

It has been accepted, since Kraussold¹ first ligated the internal jugular vein for thrombophlebitis of the sigmoid sinus, that the

spread of the infection downward could be stopped by this procedure. In theory it seems, without giving it much thought, that would be the case, but actually it seldom works out to the benefit of the patient. The vein is already collapsed, and the mere ligation in no way impedes the progress of the phlebitis.*

Due to the peculiar and inaccessible anatomic structure of the jugular bulb, it has been impossible to remove a thrombus with any type of instrument which may be inserted into the lumen of the vein from above. I have long since refrained from attempting to reach the bulb with small curved curettes for two reasons. In the first place, I know that it is impossible to reach the thrombus. In the second place, if I were able to remove the thrombus with a curette there would be too much trauma in the inner wall of the vessel, which, in the presence of an acute infection, would be very apt to produce an extension of the septic phlebitis. To overcome these previously mentioned objections, I have inserted a flexible rubber catheter which fits snugly into the opened sigmoid, connecting the outer free end with the rubber tubing on an ordinary suction pump, which is used for tonsillectomy work, passing the lower end of the catheter into the jugular bulb, while suction is continuously applied.

The removal of the thrombus may be secured in two ways. First, by pinching the catheter during its insertion and reducing the suction until the lower end of the catheter is in direct apposition to the thrombus, then allowing just enough suction to hold the thrombus against the mouth of the catheter. With the thrombus thus engaged, and the suction continued, the catheter is withdrawn, and, very happily, in a great many instances the thrombus is removed along with it. Free bleeding immediately follows and is allowed to wash out any remaining débris before the sigmoid plugs are inserted.

Should this procedure not remove the thrombus, suction is increased, the catheter is worked into the bulb, and, with the continued increased suction applied, the catheter is moved up and down against the occluding thrombus. At first, there is often a mere trickle of blood, and then a peculiar sucking noise is heard

*This subject has been discussed in a separate paper.

and the thrombus and fresh blood are withdrawn. The catheter must fit snugly enough so that very little air is withdrawn from around the wall. The catheters which I have had made are sizes 16 and 20, and of the female type with the opening in the center of the tip. The rubber must be flexible enough to follow the curves of the jugular bulb, yet firm enough not to collapse when suction is applied.

It is also advisable to watch the aspirating jar closely to ascertain the amount of blood withdrawn, because the patient could be quickly exsanguinated if the catheter were left in place with the negative pressure applied. When the thrombus first gives away the exposed dural surface collapses and may remain inverted while the suction is taking place. This is simply due to the sudden decrease of intracranial pressure. The postoperative care is no different than the usual management of sigmoid sinus thrombosis.

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XLVII.

TREATMENT OF OTITIC MENINGITIS.*

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The treatment of otitic meningitis has given rise to much discussion in recent years. Whereas formerly no attempt was made to treat the condition, it is now definitely established that some cases are amenable to operation. This paper is not concerned with epidemic cerebrospinal meningitis.

TYPES.

For purpose of analysis the following classification of meningitis may be made:

1. The acute fulminating type, which accompanies infection of the middle ear and is not secondary to it. The meningitis in these cases is no doubt due to blood borne infection. The prognosis is exceedingly grave, and operation avails nothing. Dench has called this "coincident meningitis."

2. The Nonseptic Type.—This has been called "serous meningitis," and also "meningitis sympathetica." Cases of this condition present definite clinical signs of meningeal involvement. In the spinal fluid there is a high proportion of cells, and there are definite chemical changes, but smears and cultures of the fluid do not contain organisms. Eagleton has shown that in some of these cases examination of the cerebrospinal fluid obtained at the site of the invasion gives positive results but examination of that obtained in the lumbar region gives negative results. It has been said that surgical drainage should be carried out in all these cases, for the condition is potentially septic. I shall consider this type of case in the section on treatment.

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3. This type includes cases in which all the clinical signs of meningitis are present and in which the spinal fluid, on smear or culture, is found to contain organisms, of the streptococcus, staphylococcus or pneumococcus groups. The condition may be localized or general.

VIRULENCE.

The seriousness of otitic meningitis may depend on the type of organism or on the site at which the meningitis is first made manifest. Great difference in the virulence of the different strains of streptococci is recognized. The pus in pneumococcic infections is so thick that drainage by spinal puncture often cannot be effected. Eagleton stated that most cases in which cure has been effected have followed infection of the labyrinth and evacuation of the spinal fluid through the labyrinth. Kopetzky has said that the middle cranial fossa best resists meningitis and he placed the posterior surface of the petrous pyramid as the next most resistant place. Trautman's triangle, or the inner table of the supraspinal cells, offers the least resistance to meningitis.

TREATMENT.

The treatment of septic meningitis has been both medical and surgical.

Medical Methods.—Kolmer, after much experimental work on dogs and after many attempts at utilizing his laboratory data in the treatment of meningitis in human beings, was satisfied that nothing is to be hoped for from medical treatment of generalized or diffuse pneumococcic or streptococcic meningitis in either man or dog. The outlook would be hopeful if medication could be started coincident with the invasion of the meninges, but this is obviously impossible. He suggested that at the time of the operation on the mastoid a culture should be taken and if pneumococcus is found an antibody solution and an antipneumococcic serum should be given, particularly if the pneumococcus of type I is found.

Surgical Methods.—It is agreed that the treatment of meningitis should be preceded by thorough surgical removal of the primary focus when this is possible. This requires complete ex-

enteration of the cells in cases of acute mastoiditis and radical operation in cases of chronic suppurative otitis media. If the portal of the infection has been the labyrinth, thorough drainage must be established through the labyrinth, and in all cases wide incision of the dura should be made at the site of operation.

Parkin, in 1893, and Ballance, in 1897, reported drainage of the cisterna magna. Haynes, in 1912, described his operation for continuous drainage from the cisterna magna. He did not report cures. Dandy reported three cases in which he had performed this operation but none following otitis media. It is well known that meningitis following infection of the ear is more virulent than that from other causes. The Haynes operation has been performed twice in the clinic; both patients died. Sharpe has expressed himself in favor of subtemporal drainage, and reported two cases with recovery, one in which the culture was negative and one in which streptococcus was identified.

The most brilliant results in surgical treatment of this condition have been reported by Spurling. His method should receive serious consideration in all cases. He does laminectomy, establishes continuous drainage, and then forces the intake of fluids so that the patient ingests 4 or 5 liters a day. This causes a tremendous output of cerebrospinal fluid. He stated that the sub-arachnoid drainage had a threefold purpose: (1) a portal of exit is afforded for drainage of inflammatory products which otherwise would be confined in a more or less closed chamber under varying degrees of pressure; (2) pressure within the cranial and spinal cavities is reduced, and (3) dilution of the toxins and other products of inflammation is accomplished by continuous lavage of the central nervous organs. He reported eight cases, with cure in five cases.

The question arises as to the danger accompanying spinal puncture. It is not difficult to find authorities for and against the procedure. Ballance said that in acute inflammation of the mastoid the operation is incomplete without the performance of lumbar puncture. Jenkins wrote: "Lumbar puncture is a serious procedure and should be undertaken only to obtain information as to the state of the meninges which may help in deciding the line of treatment; even so not more than 6 cc. of fluid should be

removed and that very slowly. Lumbar puncture should not be performed for diagnostic purposes when septic meningitis is suspected." On the other hand, Kolmer stated his belief that spinal drainage does not do harm and that he has not been able to produce meningitis in dogs with infections of the blood stream by removal of even large amounts of cerebrospinal fluid. At the clinic never have we seen ill effects due to too frequent removal of spinal fluid or to the removal of large amounts of spinal fluid. Cures from repeated spinal puncture have been reported by Bowers, Weaver, Huenekens, Peterman and others.

The following is a report of an illustrative case of serous meningitis seen in the clinic:

Case 1.—A man, aged 45 years, came to the clinic complaining of pain in the right temporal region and of diplopia. Two years previous to his admission, following a severe cold, he had had acute otitis media on the right side which required myringotomy. The ear discharged for two months, but with the exception of slight earache, and an occasional infection of the upper part of the respiratory tract, he had no further trouble for about a year. Following his being kicked in the right temporal region by a horse which rendered him unconscious for a short time, a swelling developed several inches behind the right ear but later subsided. About this time a severe cold in the head developed and was complicated by earache on the right side, with a slight rise in temperature. In the course of this illness, which lasted about three weeks, facial paralysis developed on the right side. An operation was performed on the right mastoid and the facial paralysis rapidly disappeared. The wound in the mastoid healed quickly, but the ear discharged for about two months. Six months after operation, pus collected beneath the incision, and it had to be opened and drained. This drainage continued until two weeks prior to the patient's admission at the clinic. Frequently, the patient suffered pain in the right ear with slight increase in temperature. The pain became more severe, extending down to the right side of the jaw, and he noticed that he had double vision on looking to the right. This symptom occurred five days before admission.

Examination revealed paralysis of the right external rectus muscle and very slight discharge from a small sinus in the mastoid wound. The patient had some fever and gave the appearance of being extremely ill. He was hospitalized and spinal drainage was done. The culture was reported negative. Polymorphonuclear cells numbered 2,500 and small lymphocytes, 300 in each cubic millimeter of spinal fluid. The neurologists made a diagnosis of serous meningitis. Spinal drainage was repeated in the afternoon of the same day; the pressure of spinal fluid was 28 cm. of water before drainage and after drainage 8 cm. There was prompt response to pressure on the jugular veins. The third spinal drainage was done the next day and cultures were negative; polymorphonuclear leukocytes numbered 600 and lymphocytes 300. Pressure was 30 cm. before drainage and 8 cm.

afterward. Spinal drainage was repeated the following day also. During the patient's stay in the hospital, spinal drainage was done six times with negative cultures. The patient improved rapidly and was dismissed from the hospital. Examination of the ocular fundus had been negative throughout, and the day after admission to the hospital the paralysis of the right external rectus muscle had almost disappeared.

The patient remained under observation after dismissal from the hospital. In about a month he complained of headache, but examination did not disclose recurrence of the paralysis nor were there significant ocular signs. He was sent to the hospital, where a spinal drainage was done, and the culture was negative. The pressure was 25 cm. before drainage and 6 cm. afterward. After this period of observation, he was dismissed from the clinic; the wound over the mastoid was dry and the diplopia had entirely disappeared. The extraocular muscles were in good condition. The headaches had disappeared, and examination of the ocular fundi gave negative results.

In the course of the next two years, the patient was observed in the clinic at intervals. The mastoid fistula persisted, but there was no pain or recurrence of the ocular disturbance. October 16, 1930, the patient came under observation with complaint of diplopia, headache, and soreness around both eyes which followed a cold in the head which he had had for two or three weeks. The nasal infection cleared but the headache and diplopia persisted. There was some drainage from the ear at intervals.

On examination, partial paralysis of the left external rectus muscle was found. It should be recalled that it was the right external rectus which was affected at the time of the previous illness. The patient was examined in the neurologic department and spinal drainage was advised. This gave negative results except for the Nonne test, which was positive. Exploration through the old mastoid wound was done October 29, 1930. The antrum was found to be filled with infected granulation tissue and some cells, found above the middle ear, between the apex and the petrous portion of the temporal bone, contained encapsulated pus. The dura was reddened at this point. Following operation, the patient made an uneventful recovery. The wound healed and the paralysis of the left external rectus muscle disappeared.

Comment.—The question of operative treatment in serous meningitis is not settled. Smith said that one must not be misled by the diagnosis of serous meningitis, as it is the forerunner of diffuse suppurative meningitis. Kopetzky classified all cases of sympathetic meningitis as surgical meningitis, except those due to brain abscess. I think the original focus should be cleaned out, if possible, in case of serous meningitis, and if organisms are not found on smear or culture, repeated spinal drainage is the treatment of choice.

The following report is of a case of hemolytic streptococcic meningitis in which there was a Gradenigo syndrome. Recovery

followed spinal drainage. In two other cases in which the streptococcus was found, the patient recovered, but since the organism was found only once in the course of several examinations I hesitate to include them as instances of definite recovery from streptococcic meningitis.

Case 2.—A girl, aged seven years, was brought to the clinic August 16, 1929. The history was that in the previous July acute otitis media had developed following coryza. The ear drum had ruptured spontaneously one week after the onset of the trouble and paralysis of the left external rectus muscle had developed, with some drooping of the upper eyelid. The complete mastoid operation had been performed. For several days following operation, the temperature had not risen above 102° F., but in the nine days previous to admission the temperature had reached 105° F.

On the child's arrival at the clinic, she seemed apathetic, drowsy, irritable and in pain. The temperature was 104° F. and the pulse rate each minute 110. There was paralysis of the left external rectus muscle. Examination of the ocular fundi gave negative results. Leukocytes numbered 9,600 in each cubic millimeter of blood. The spinal fluid, which was under pressure, contained 101 small lymphocytes, 75 large lymphocytes, and 1,637 polymorphonuclear leukocytes in each cubic millimeter. Hemolytic streptococci were present. The results of blood culture were negative. The high temperature continued. A second spinal drainage was done on the day following the patient's admission to the hospital; the fluid was cloudy and was under a pressure of 24 cm. of water before drainage and 10 cm. afterward. The fluid contained hemolytic streptococci. A third spinal drainage was done August 20th, when 25 cc. of cloudy fluid was withdrawn. It contained 101 small lymphocytes, 8 large lymphocytes and 215 polymorphonuclear leukocytes in each cubic millimeter. There was no growth of organisms in culture. The patient appeared to brighten up and the daily excursion of temperature was not so pronounced. There was some fullness of the veins of the ocular fundi and some blurring of the margins of the disks. The left external rectus muscle was still paralyzed. August 22, a fourth spinal drainage was done and 12 cc. of clear fluid was withdrawn. The pressure was 18 cm. before drainage and 11 cm. afterward. There was still some rigidity of the neck but the child was doing very well. It was thought that an abscess might be forming. On culture of the spinal fluid, only one colony of hemolytic streptococci appeared. Two days thereafter spinal drainage was done a fifth time, and 25 cc. of clear fluid was withdrawn; pressure was 32 cm. before drainage and 8 cm. afterward. There were 54 small lymphocytes, 4 large lymphocytes and 9 polymorphonuclear leukocytes in each cubic millimeter of spinal fluid. There was daily improvement in the patient's condition generally and the temperature remained below 102° F.

September 16, there was marked edema of the optic disks with some perivascular hemorrhage and exudate. The left external rectus muscle was improving in function. The test of hearing gave normal results. Formation of a brain abscess was still expected, for the patient had severe headaches daily, with slight elevation of temperature. Spinal drainage a

sixth time revealed 70 cells in each cubic millimeter of fluid and culture gave negative results.

October 1, ophthalmoscopic examination disclosed edema of both optic disks, graded 3, with hemorrhage and exudate. Neurologic examination, September 1, had revealed a questionable Babinski sign on the left, and rapid tremor of the upper extremities that was suggestive of encephalitis. However, improvement was gradual and October 6, ophthalmoscopic examination disclosed lessening of the edema and exudate. The paralysis of the external rectus muscle had practically disappeared. The child was dismissed from the hospital October 24. The temperature had been normal for two days. In all, spinal drainage was performed nine times after three of which hemolytic streptococci were found in the fluid. A recent letter stated that the patient was in good health.

CONCLUSION.

1. The original focus should be thoroughly removed. A wide portion of dura should be uncovered and free drainage established through the dura.
2. Smears and cultures should be made of the spinal fluid.
3. Spinal drainages should be performed repeatedly and the intake of fluid should be increased.
4. If the culture is positive, continuous lumbar drainage, as advised by Spurling, should be considered.
5. All hope seems to lie in surgical treatment, not in medical treatment.

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XLVIII.

AN APPROACH TO CARCINOMA OF THE CERVICAL
ESOPHAGUS: TWO STAGE OPERATION
WITH DIATHERMY.*

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Since Billroth, in 1871, first attempted resection of the cervical esophagus for cancer, great effort and much ingenuity have been spent on experimental animals and human sufferers. The voluminous literature, however, is a rather sad record of failure in one of the most desperate conditions to which mankind is subject. Saint, in his comprehensive survey of the literature to the end of 1927, could find only two clear-cut cures. Only a few doubtful ones have been added since.

My experience with diathermy in a considerable variety of cases led me to believe that it offers greatly improved results where it can be applied. From this conviction came the attempt here described to make the esophagus more accessible to its action. The employment of the two-stage operation in diverticula and deep neck infections suggested a method. Experiments in dogs with a preliminary pack of the deep cervical spaces made the method seem relatively safe. Its application to two patients, though not finally successful, has made it seem to offer definite possibilities.

To recount in full the difficulties of dealing with carcinoma of the esophagus is to state an almost insuperable problem. Late diagnosis of a lesion that as a rule sends the patient to the doctor only when it has reached the obstructive stage is a prime factor in failure, because of its relative malignancy. Souttar believes because of this that radical removal, except in unique cases, is a

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pathologic impossibility. Vinson and Broders, on considerations of the histologic types, believe the impression is erroneous that early diagnosis and perfection of technic will result in complete removal without recurrence in a reasonable number of cases.

On the other hand, Helsley, in a careful postmortem study of 70 cases that came to autopsy, found that in 64 per cent the carcinoma was confined to the esophagus. From a comparative study of cases kept alive by gastrostomy he believed that while late in the disease the metastases are extensive and rapid, in the majority of cases ample time is given for diagnosis and treatment before metastases occur. Blauwkuip found in 125 postmortems of cases dying with carcinoma of the esophagus that in 80 there was no remote metastasis, and in 59 there was no gland involvement. It must be considered that postmortems give the worst possible aspect of the disease, and also, though the histopathologic picture may be one of great malignancy the clinical outlook may be changed by other factors, as, for instance, the fascial limitation of this hollow organ, with scant lymphatics, whose open lumen presents a less resistant direction for growth. Billroth, Steward and many others believe that, given a satisfactory method of attack, the time from the first symptom of the disease will be ample for its detection and destruction. Abel says that one in three of all cases should be operable.

Esophageal surgery has been difficult because of the absence of serosa, which makes possible success in abdominal surgery. Also the esophagus is so situated that infection of its bed, as its surgery has usually been done, has frequently led to descending infection of the deep visceral space, the mediastinum, the pleura and the lungs. Without reviewing in detail the anatomy involved it is sufficient to recall that the esophagus lies in the visceral or middle of the three main fascial compartments of the neck; that the fascia bounding it is split from the carotid sheath and that the space made is continuous below without partition, from the posterior mediastinum. Fluids or instruments pass downward with almost no resistance unless a previous adhesive or exudative process has existed. Infection from the neck can easily find this same path and when it does the outlook is serious.

(The writer has passed an esophagoscope in the dog through a neck incision along the wall of the esophagus, with almost no force, nearly to the hiatus, with good observation of the esophageal wall. The animal had apparently no bad after effects and the procedure might be used for exploration before attempted thoracic operation.)

The surgery of esophageal diverticula was extremely hazardous until Goldman, in 1909, proposed packing around the isolated sac for a period before opening, in order to develop local immunity and to allow granulation and exudate to wall off infection. Since then the operation has been a very safe one. Marschik and others employed the same principle in dealing with infection that threatened the deep spaces of the neck. New uses a somewhat similar idea in his two-stage thyrotomies. An adaptation of this method seemed to the writer worth a trial in the esophagus, and in a series of experiments on six dogs he was able to satisfy himself that by it manipulations on this organ could be made with relative safety.

In brief, the method was this: Through a median or left paramedian incision low in the neck, the esophagus was reached on both sides behind the trachea and medial to the great vessels and the vagus and recurrent nerves. The organ was freed at the level of the lower end of the wound by blunt dissection, chiefly with scissors, and even slightly traumatized to promote reaction. Iodoform gauze was packed in the lower angles of the wound on both sides of the esophagus. One week later the esophagus was isolated above this level and brought up through the wound after repacking below. Sections of the esophagus were destroyed by electrocoagulation at this time in some cases; in others, the esophagus was only opened by diathermy puncture, the wound flooded by secretions and the operation completed in another week. The lower segment was held by sutures to the neck wound, or by sutures to a rubber tube in its lumen brought out through the wound.

These experiments were inconclusive in a way under the conditions of the work. Gastrostomies were not made and the administration of fluids by hypodermoclysis and transfusion was not done, as seems to be necessary in the dog after such operation,

and proper nutrition could not be maintained. The dogs did not long survive resection, yet in spite of the fact that asepsis was not perfect and gloves had not been worn in the experiments, at later operations and autopsy in only one animal was there found evidence of descending infection. From these experiments, at least, it seemed possible to handle the esophagus with some degree of safety after preliminary packing.

Not until this conclusion had been applied to my first human case did I learn that Neuhof and Ziegler, in 1922, had beautifully demonstrated this principle in a finished piece of experimental work which had for its stated object the reconstruction of the esophagus by granulation. They noted that while the single stage operation was not successful, not a single dog died on which a preliminary packing had been done for the formation of a bed of granulations before the lumen was opened.

There is hardly space to consider in detail the advantages of surgical diathermy or its technic. With increasing experience the results have been relatively so favorable that I have employed it more and more and have come to believe that for carcinoma about the head and neck it is, with a very few exceptions, the method of choice.

Diathermy through the esophagoscope has already been used to some extent. Wright has employed it in many cases, especially as a palliative to restore the lumen which was blocked by neoplasm. He uses a special instrument consisting of insulated shaft, flanged disc electrode and bougie tip. This is passed beyond the growth. Traction is made as the switch is turned on, and the instrument cuts its way out, destroying malignancy to the diameter of the electrode. Wright believes the method safe and the best palliative treatment. It seems too uncertain, however, to hope that by it a carcinoma can be completely eradicated.

By diathermy through the esophagoscope the writer was able in the dog to destroy areas of esophageal mucosa up to several centimeters in width with rather rapid healing and no bad effects. Both a single fine electrode and a special double electrode carrying both terminals as fine tips separated by about 4 millimeters were used. The mucosa was transfixed and lifted from its bed

before coagulating, and a sharply localized effect was secured with dangerous infection apparently prevented by the sterilization and the sealing of lymph spaces. It was found difficult to apply this accurately in the depth of even the short esophagoscope, and it is doubtful if many growths will be seen early enough to be attacked by this method. Hesse has recently reported eight cases of carcinoma of the thoracic esophagus treated endoscopically by diathermy with pointed and ball electrodes with the immediate results good. (It may be mentioned, in passing, that Seiffert has apparently successfully excised a carcinoma through the esophagoscope.)

It seemed to the writer that if carcinoma of the esophagus is to be cured by diathermy it must be by a method that gives adequate exposure, either of the whole isolated organ or at least of a freely visible surface of its growth, as could be seen only by external approach. This led to the work previously outlined, and to its application to the following cases:

Case 1.—J. H., a 70-year-old laborer of German extraction, came July 21, 1930, six weeks after the onset of obstructive symptoms. Roentgenograms showed a high esophageal defect. Esophagoscopy demonstrated just below the cricoid narrowing a fungating ulcerated mass bulging into the lumen. The Wassermann report was negative. The biopsy report was: Squamous cell carcinoma with hornification. Sippy dilators and Jackson bougies were passed for a time, but the patient refused to co-operate and a gastrostomy was performed on the surgical side by the Witzel method August 22nd.

September 15, 1930. First stage operation. Under infiltration anesthesia longitudinal incisions were made on either side low in the neck, medial to the anterior border of the sternomastoid muscles, and the esophagus was reached between the trachea and the great vessels and nerves and partly separated from its bed. This was not difficult on the right, but on the left a large thyroid lobe was matted to the surrounding structures by what appeared to be inflammatory infiltration with a center containing several cubic centimeters of thick yellow pus. This was thought to be due to injury from previous attempts at dilatation. With dif-

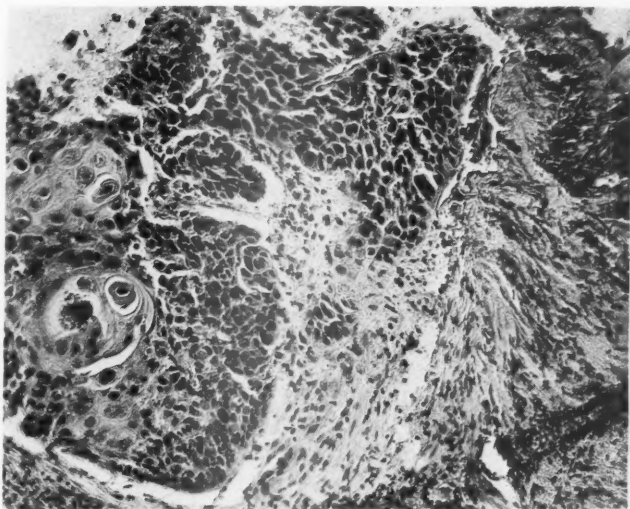


Fig. 1. Case 1.—Biopsy section, Squamous cell carcinoma with hornification.

ficulty the thyroid was reflected down and medially so that the esophageal wall was uncovered. Iodoform gauze strips were packed deep in the angles of the wound and partial closure made with silkworm gut. Two days later laryngoscopy showed edema of the glottis and the packs were removed. The temperature rose only to 99.4 and the pulse to 112.

September 20, 1930. The left incision was reopened and extended to the level of the thyroid cartilage. There was some bleeding, controlled easily with the diathermy spark. The left superior thyroid artery was ligated. The thyroid gland was retracted medially, the esophagus exposed at the level of the third tracheal ring and opened with electrocoagulation over an area 1.5 centimeters long and 1 centimeter wide. The granular mass presenting was also coagulated in part. A No. 18 tube was inserted towards the stomach in the esophagus and a pack was placed below around the esophagus. That evening there was marked respiratory embarrassment, relieved by low tracheotomy.



Fig. 2. Case 1.—Completion third operation. Upper tube from esophagus, lower from pharynx.

October 3, 1930. Under avertin anesthesia electrocoagulation of the remaining mass was done, beginning at the open lumen of the esophagus and working up and down with a coarse needle and small ball electrodes. No effort was made to first isolate the esophagus, but the area being coagulated was drawn as far away as possible from vagus and the great vessels. In clearing the upper segment, the point of the electrode introduced through the neck wound was guided by the short esophagoscope from above. Tubes were passed from the pharynx and lower segment out through the wound, which was packed wide open with iodoform gauze. The temperature rose the next day to 102 R. and the pulse to 120, but both were normal by the third postoperative day. There was little pain or shock at any time. On the tenth day the catheters were removed and a 7-millimeter tube was inserted into the lower segment of the wound and the upper half of it slid back into the pharynx. This tube was held in place by a finer one transversely through its side and around the patient's



Fig. 3. Case 1.—Two weeks after final operation. Tube in distal segment.

neck. The patient left the hospital October 20th. The vocal cords moved normally, and the patient's general condition was good at that time. Two months after the last operation the patient died at home, apparently of acute asphyxia, and partial postmortem showed carcinomatous infiltration of the larynx.

Comment.—If the operation had not been delayed while data was being accumulated by experimental work the chance would probably have been excellent. A three stage operation was done because the first packs had remained in place only two days. After the preliminary flooding of the wound it seemed unsafe to attempt to isolate the esophagus. Diathermy through the previous wound and open lumen is probably a much safer procedure but is more uncertain and less likely to result in complete destruction of infiltrating carcinoma. Examination shortly before death indicated there was forming on the bed of the granulations a lumen with epithelization, as Neuhof and Ziegler found in experimental animals.

Case 2.—A. R., a 63-year-old married salesman, came September 28, 1930, complaining of dysphagia of two or three months' duration, of a dull ache in the neck for a shorter time, and of the loss of twenty pounds of weight. He swallowed liquids fairly easily but solids only with pain. He was weak and emaciated but did not seem acutely ill. The cords moved normally, but the left was injected. An ulcerated cauliflower mass rolled over the posterior edge of the arytenoids and an esophagoscope could not be passed. No cervical glands were felt. Roentgenogram with barium meal showed a tail-like narrowing of the upper one-third of the esophagus. The biopsy report was "very anaplastic cell carcinoma."

September 29, 1930. Under avertin anesthesia, with skin infiltration, incisions were made on each side from the level of the cricoid almost to the sternum, midway between the anterior border of the sternomastoid muscle and the midline. In this thin patient the carotid sheath was easily pushed laterally and the esophagus easily exposed and isolated in the lower angles of the wounds. Palpation and inspection revealed a spindle shaped mass about 4 cm. in diameter above, where it was attached firmly, but freely movable lower down, with an apparently normal esophageal tube below the level of the sixth dorsal vertebra. Curved forceps were passed posterior to the esophagus and out through the opposite wound, and pulled through to grasp a gutta percha strip and flat iodoform 2 cm. wide, which were left extending under the esophagus and out through the incisions. Silkworm gut closed the upper end of the wound. This exploration indicated that the lesion might be operable, so the patient was transferred to surgery for a Witzel gastrostomy, which was done October 2, 1930, without complications.

October 7, 1930. The iodoform gauze was removed, leaving the gutta percha.

October 10, 1930. Under avertin anesthesia, the wound was reopened and extended on the left above the hyoid level. The esophagus was easily isolated posteriorly, starting at the gutta percha pack. With more difficulty it was separated by a gloved finger from the posterior tracheal wall, nearly to the cricoid. A

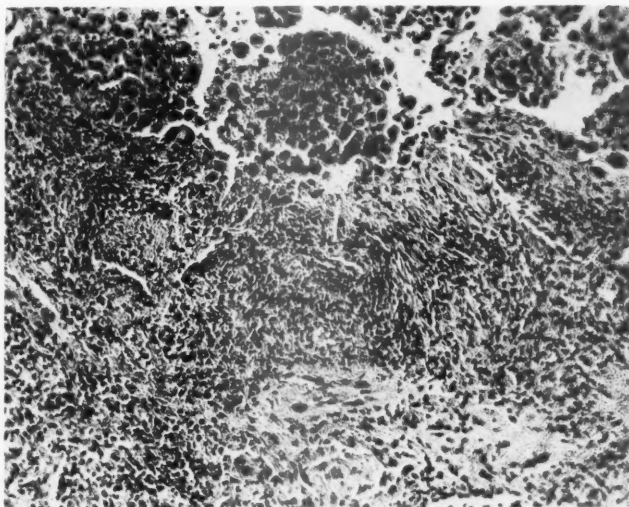


Fig. 4. Case 2.—Biopsy section. Anaplastic cell carcinoma.

through and through iodoform strip was placed behind the esophagus and others packed in the lower angles of the wound on either side. The thyroid cartilage was prepared for a transthyroid pharyngotomy, but this was not necessary, as destruction of the mass gave free access to the hypopharynx. The mass was attacked with electrocoagulation up into the pharynx posterior to the great cornu of the hyoid. It filled an extended lumen and overflowed into both pyriform sinuses. A low tracheotomy was done and the trachea pulled to the right while the mass of tumor was destroyed. The lower segment of the esophagus was not displaced, but, from within, the tumor mass was destroyed below its lower border. The outer skin wound was sutured over the carotid sheath to the prevertebral muscles and the wound packed wide open. Packs previously placed were not disturbed. That day and the next the patient was weak and had a rectal temperature up to 103.2, but there was little shock or pain. Secretion from the trachea was profuse and saliva flooded the neck wound, which was kept as clean as possible with suction.



Fig. 5. Case 2.—Before second stage. Through and through gutta percha sling in place posterior to esophagus.

October 23, 1930. A fistula into the trachea from the neck wound developed, apparently from a coagulated area just below the cricoid cartilage. Wound secretions flooded the trachea and a cofferdam pack could not entirely shut them out. Death occurred from bronchopneumonia nineteen days after the last operation.

Autopsy could not be obtained. At no time were there findings of descending infection or symptoms of mediastinitis, although, of course, these could not be ruled out without postmortem examination.

Comment.—This case may suggest the advisability of not attempting such a radical procedure, yet this was an extreme involvement and the patient might perhaps have survived if the trachea had been better protected.

Although this was histologically a very malignant growth it appeared limited to the esophagus, except at its upper end, where

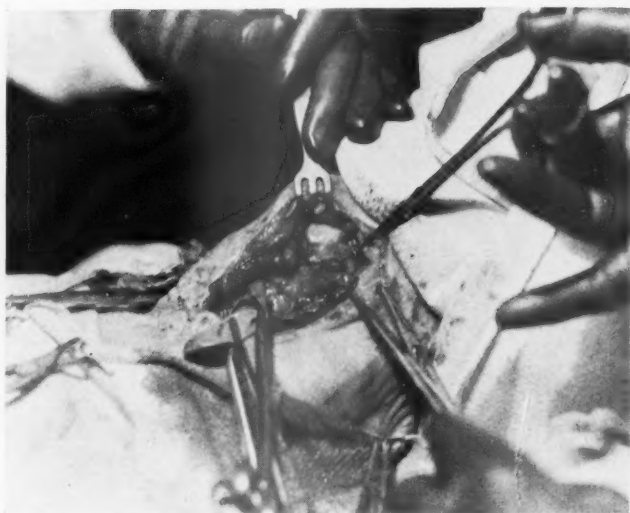


Fig. 6. Case 2.—Second stage operation. Thyroid ala bared; forceps in hand rests on tumor posterior to opened pharynx.

it overflowed into the hypopharynx. For a small tumor the procedure here followed would seem reasonably safe with at least a fair hope of success. If normal esophagus were found above and below the tumor mass, simple excision would perhaps suffice, though I should still prefer destruction by diathermy.

The advantages of the two stage operation appear to be:

1. It greatly lessens the danger from descending infection.
2. It is associated with no great shock, infection or much danger of hemorrhage.
3. Its first stage may serve as an exploration, and if hopeless infiltration or gland involvement is found the operator may retreat without opening the lumen of the organ, usually to no great detriment of his patient.
4. It permits reconstruction of the destroyed esophagus by granulation, after the method of Neuhof and Ziegler, which looks perhaps the most practicable.



Fig. 7. Case 2.—Tumor half destroyed. Left hand holds electrode on tumor.

It has some real disadvantages. After preliminary manipulations the structures may be matted together, disguised by granulations and hard to distinguish. This may be partly obviated by the sling pack placed around the tube at the first operation. The lower segment might not be sufficiently anchored by granulations and might retract, but if necessary it can be fixed by mattress sutures. Severe secondary hemorrhage will always be possible, but all of the main branches should be identified and secured.

The other possibilities should perhaps be discussed in relation to direct surgical attack. Gastrostomy may prolong life considerably and should, if it is to be done, not be postponed until the patient is so weakened that it becomes a dangerous procedure. At best the patient with it only ekes out a little more of an unhappy existence except where it is used to prepare him for more hopeful procedures. X-ray seems to have met with little success. Radium has done better as a palliative, and Guisez has reported three five-year cures by it, but no one else has had his success. Intu-

bation, in the hands of Souttar and Jackson in a considerable number of cases, seems to have given an extended period of nearly normal life, although others have not been so enthusiastic about it. In some cases where I have used it the patients have been very comfortable for a time. It cannot be used in the neck on account of tracheal irritation. Dilatation as by the Plummer method has been recommended by Vinson and others as perhaps the best method.

Altogether these methods have been rather uncertain, and their relative failure would seem to justify the attempt at radical cure in a condition that is hardly better than death.

SUMMARY.

The attempt has been made to develop a method by which surgical diathermy may be applied to carcinoma of the cervical esophagus with adequate exposure.

A preliminary pack is placed around the esophagus, low in the neck, to develop local immunity and to cause exudate and granulations to seal off the deep spaces. This appears to make later manipulations relatively safe.

Diathermy was used after such a pack in two patients, in one applied through the opened but not isolated organ; in the other, after nearly complete separation of the cervical esophagus from its bed. The experience with this method gives hope that some cases of carcinoma of the cervical esophagus may be radically cured by it.

636 CHURCH STREET.

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XLIX.

OTOLARYNGOLOGICAL TREATMENT OF CHRONIC ULCERATIVE COLITIS.*

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It may seem unusual for a chronic disease of the colon to directly interest the otolaryngologist. However, removal of distant foci of infection, as we have all experienced, is frequently the major factor in eradicating many pathologic conditions; so it has proven to be in the case of chronic ulcerative colitis.

HISTORY.

This chronic disease of the colon, including the sigmoid and rectum, has been known for many generations but always referred to as *idiopathic* chronic ulcerative colitis, since the etiology was unknown and the pathology and symptoms were confused with several other chronic diseases of the above mentioned portion of the gastrointestinal tract. As a result of the incomplete understanding of the disease the treatment was uniformly unsatisfactory until Dr. J. A. Bargaen,¹ in collaboration with Dr. E. C. Rosenow² of the Mayo Clinic, isolated, in 1924, the organism responsible for the condition.

BACTERIOLOGY AND PATHOLOGY.

Previous to Dr. Bargaen's discovery, the infection was attributed to various bacteria, including the bacillus coli, Welch's bacillus and bacillus dysentericus. Research has proven that ulcerative colitis is no longer idiopathic in nature, but a definite clinical entity caused by a diplococcus and now known as the diplococcus of Bargaen. The organism is thought to belong to the streptococcus group, is lancet shaped, Gram positive, and resembles closely the pneumococcus. It has been found to grow best on a

*Presented as candidate's thesis to American Laryngological, Rhinological and Otological Society, Inc., St. Louis, June, 1931.

dextrose brain broth, but unless special care is taken the culture is soon replaced with the staphylococcus.

The infection by this diplococcus first involves the mucosa of the rectum, to be followed, as the disease progresses, by involvement of the sigmoid, descending, transverse and ascending colon, and, in a few cases, the adjoining portion of the small intestine. The mucous membrane is at first congested and edematous, which is soon accompanied by innumerable miliary abscesses that can easily be seen with the protoscope. These abscesses soon break down, producing myriads of minute ulcers, which soon coalesce, forming a larger and larger ulceration. Eventually the submucosa and muscularis become involved, with resulting narrowing of the colon by spasm and contraction as well as loss of haustrations and foreshortening of the gut. When healing occurs, a characteristic pitting of the mucous membrane can be seen through the proctoscope, indicating the previous location of the large indefinite number of small abscesses. No other disease of the rectum, sigmoid and colon produces such a characteristic pathologic picture.

SYMPTOMS AND DIAGNOSIS.

The symptoms depend entirely upon the extent of the pathology. When the infection is in its incipency and consequently involving the rectum alone, the patient complains only of frequent rectal discharges of mucous, blood and pus. At this stage of the disease constipation may obtain, but as the disease ascends the colon the symptoms become more and more pronounced. The patient begins to lose weight, appears anemic and has abdominal distress with cramps, tenesmus and increasing number of discharges of blood and pus mixed with fecal matter. Although there is an acute and sometimes fulminating type of the disease, the condition is usually chronic, covering several years, during which time the patient is practically an invalid. Radiographs, after barium enemas, give interesting information in the form of absence of haustrations, foreshortening of the bowel, with narrowing of its lumen due to spasm and contraction. This data, along with symptoms and protoscopic findings, formulate a picture that should be difficult to confuse with other lesions of the colon. In addition, recovery of the causative organism helps to

make the diagnosis certain. Complications, such as hemorrhage, fistula and peri-rectal abscess may occur, as well as local and general peritonitis, due to rupture of an ulceration. Distant effects in the form of endocarditis and arthritis have been reported.

TREATMENT.

It is at this juncture in the discussion of the subject that the otolaryngologist becomes directly interested, as well as helpful to the patient. Although it had been suggested that chronic ulcerative colitis was probably an infectious process, it not only remained for Dr. Bargen to recover and isolate the offending diplococcus but to reveal that chronic infection of the upper respiratory tract is the most important factor in the production of the disease. About the time of the announcement of this discovery I had occasion to examine the nose and throat of a woman who had been suffering from diarrhea and all that attend it for about fifteen years. She was sent to me by a very capable and wide-awake proctologist who had obtained the diplococcus of Bargen from her sigmoid by use of the protoscope. He asked that I study the bacterial flora of her mouth, pharynx and nasal cavities, and to our surprise was able to recover, in pure culture, the diplococcus of Bargen from the tonsillar crypts. Enucleation of the tonsils resulted in immediate cure of her diarrhea without further treatment. As this was a rather typical case, I shall speak more fully of it under case reports. This patient was followed by others, most of which have been proven to have the source of their infection in the tonsils, but not invariably so. The infection of the teeth in the form of apical abscesses or pyorrheal pockets has been found in a few patients. But in no case have we been able to find the infection in the nasal cavities or accessory sinuses. It is also interesting to note that when the organism has been recovered from the tonsils and abscesses of the teeth it has been found in pure culture. This is especially unusual in the case of infection of the tonsillar crypts, where bacteria of a wide variety have commonly been found. When attempting to secure a specimen from the tonsils, we first spray the throat with normal salt solution, followed by the application of suction through a glass tonsillar aspirating tip. Vaccine made from the diplococ-

cus and administered following the removal of the focus or foci has been proven helpful in some cases that cleared slowly, but usually after eradication of all discoverable distant foci the diarrhea soon disappears. This has been uniformly true if the diplococcus has been recovered from the colon as well as from the upper respiratory tract.

RESEARCH.

Attempts to produce lesions in the colon of lower animals were at first unsuccessful. We worked with rabbits and later with young dogs, as previously suggested by Dr. Bargaen. The dogs were around five or six months old and weighed about 4000 grams. A single intravenous injection of 8 to 10 cubic centimeters of pure culture of the diplococcus failed to produce any localized pathology whatsoever, but frequently the organisms could be recovered from the blood stream before death and from the heart blood at autopsy. Daily injections for a week caused lesions to form in the colon in four of the dogs, there being eight in all. They first lost weight rapidly and developed a mild diarrhea in the course of four to five days. The diarrhea gradually grew worse with the appearance of blood and pus. Two of the dogs died, one was autopsied at the height of its infection, while the fourth recovered after intravenous injections were discontinued. Rabbits, through the veins of the ears, offered a much easier avenue of insertion of the infective material, but the selective action on the colon was less frequently evidenced. The superficial veins of dogs, especially when not full grown and of comparatively small stature, are difficult to inject daily. We found the veins coursing over the knees of the forelegs and just above and external to the hocks of the hind legs the most favorable locations. Shaving must be resorted to, and even then daily injections are tedious, as thrombosis of the veins is frequent due to greater difficulty in entering the veins of dogs and inability to keep the dog quiet.

REPORT OF FOUR CASES.

Case I.—Mrs. S. E. T., age 35 (referred to under treatment). The chief complaint was diarrhea with from eight to twelve stools a day for the past four years. The past history was unessential excepting that she had been treated by various physicians without any benefit. She had been cared

for without improvement for six weeks by a proctologist who referred her to me for nose and throat examination with emphasis on attempt to isolate the diplococcus of Bergen. Examination showed small, somewhat submerged tonsils. Aspiration revealed moderately increased exudate. Investigation of the specimen by the pathologist showed a pure culture of the diplococcus of Bergen. The ears and nasal sinuses were normal. Tonsillectomy was performed under local anesthesia. Autogenous vaccine was expected to be given the patient after removal of the tonsils, but the patient was quarantined on account of scarlet fever in the family. At the time of the removal of quarantine, in the course of a few weeks, the patient was having one normal stool a day. This patient was operated upon September 4, 1927, and has regained her lost weight and has been free from all symptoms of colitis since that time.

Case II.—Mr. D. M., age 33. This patient presented himself to the proctologist, Dr. A. J. Chisholm,³ complaining of symptoms similar to the above mentioned case for one and one-half years and had been treated by numerous physicians for so-called idiopathic colitis. He had his teeth removed several months previous to our first examination, which had helped his diarrheal condition to some extent. The history of any ear, nose and throat trouble was negative. His general health had always been good until colitis developed but since then had lost fifteen pounds in weight. The Bergen organism had been found in the colon by Dr. Chisholm. Examination of pharynx and nose showed evidence of chronically infected tonsils, nasal septum deviated to the right, antra transillumination decidedly cloudy and a slightly increased mucopurulent discharge in each naris. Normal salt solution was injected into the antra by needle puncture and then recovered for culture but no diplococcus could be grown. After cleansing the throat, aspiration was applied, with recovery of the diplococcus by the bacteriologist. Tonsillectomy was performed December 12, 1927, followed by autogenous vaccine. The patient cleared up in the course of a few weeks, and has remained perfectly well since. I believe that this man would have recovered without vaccine but it was strongly advised by the proctologist and consequently administered.

Case III.—Mr. B. T., age 65. This man began with fever of 102 degrees, rapid pulse, and prostration accompanied with bloody diarrhea. The internist was unable to make definite diagnosis until he solicited the aid of the proctologist who recognized the protoscopic picture of an acute ulcerative colitis. Search for distant foci of infection resulted in the recovery of the diplococcus from the teeth and tonsils. Eradication of these foci resulted in immediate recovery of the patient.

Dr. Bergen⁴ has suggested the use of specific, immune serum in the acute fulminating cases. The serum is produced by the injection of horses with recently isolated strains of the organism. As we have had no fulminating cases and our only acute one, reported above, cleared with attention to teeth and tonsils accompanied by appropriate medical care, we are not in a position to speak as to the efficacy of the serum.

Case IV.—Mr. L. L., age 35. This patient gave a history of diarrhea, passing blood and mucous every two to three hours for the past five years. Tenesmus with abdominal distension was more marked than in our previous patients suffering with this disease. He appeared exceedingly thin and anemic, having lost thirty-five pounds since the diarrhea began. His

red cell count was 2,300,000 and hemoglobin 40 per cent. He was treated in Lincoln and Omaha, Nebraska, since his trouble began but with no results. The diplococcus was isolated from the sigmoid by Dr. Philip Hillkowitz of Denver who likewise recovered the organism from a specimen taken from the tonsils by aspiration. Tonsillectomy was performed under local anesthesia on April 9, 1930. This patient was last seen on August 22, 1930. At that time he was not perfectly well but was delighted with the result and had returned to his usual vocation as a farmer.

SUMMARY.

It appears that the otolaryngologist should be playing a more important part in the treatment of chronic ulcerative colitis. The history of the patient having diarrhea for a number of years without any effective treatment should at least arouse a suspicion of the true cause of the malady. The protoscopic picture of small but multiple abscesses and ulcers, or the hammered copper appearance when healed gives valuable information. The recovery of the diplococcus of Bargen from the ulcers, followed by securing the same organism from the tonsillar crypts, pyorrheal pockets or apical abscesses adds to the making of an accurate diagnosis. The characteristic X-ray findings following barium enemas, in the form of narrowing of the lumen of the colon with foreshortening and absence of haustrations, form no negligible factor in differentiating this colonic disease. A tonsillectomy usually suffices to effect a cure of the diarrhea, but it must be borne in mind that other foci of infection, such as those of dental origin and gall bladder, can be etiologic factors.

No doubt we, as otolaryngologists, are going to see more of these patients, as the general practitioner, as well as the internist and proctologist, make a better differential diagnosis of various forms of disease of the large bowel and consequently remove chronic ulcerative colitis from the idiopathic variety.

110 METROPOLITAN BLDG.

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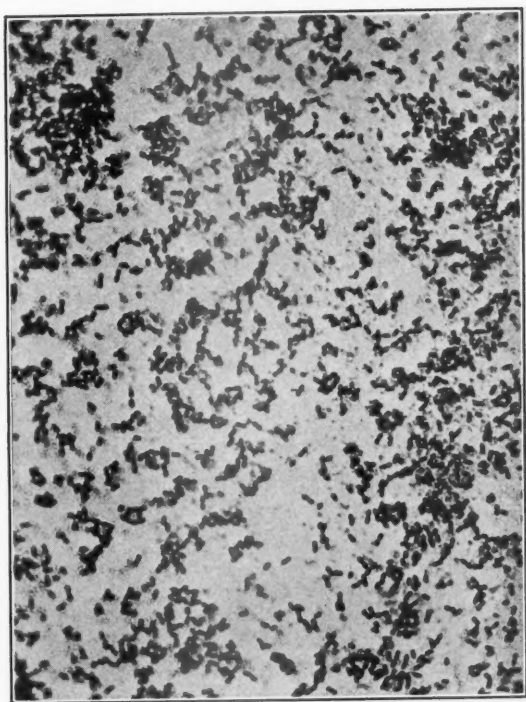


Fig. 1. Photomicrograph of the diplococcus of Barga.

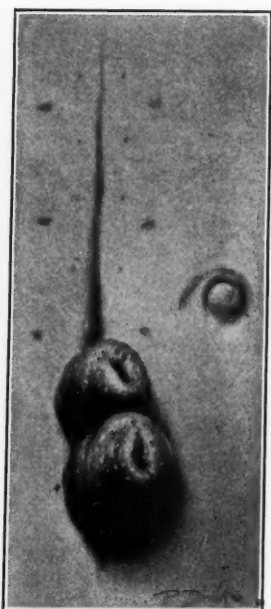


Fig. 2. Miliary abscesses in acute exacerbation of chronic ulcerative colitis following colostomy (Bargen).



Fig. 3. Showing intestinal lesions in Experimental rabbits.



Fig. 4. Barium enema in experimental dog showing contraction of colon in ulcerative colitis.

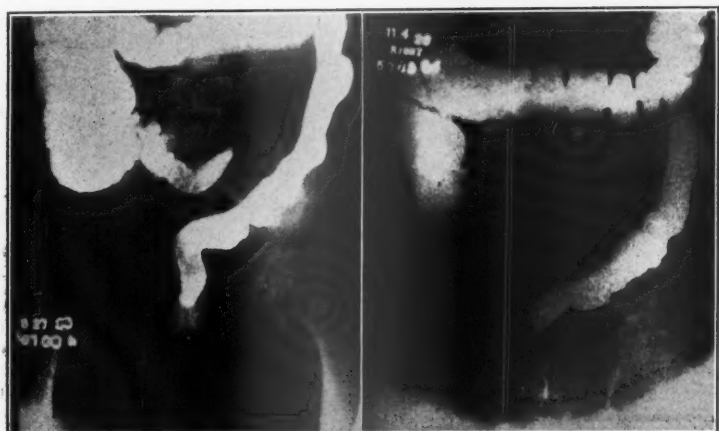


Fig. 5. Radiographs following Barium enemas before and after treatment (Bargen).



Fig. 6. Radiograph of recent case showing narrowing of bowel especially of rectum and sigmoid with loss of haustrations.

L.

VEGETABLE FOREIGN BODIES IN THE TRACHEA
AND BRONCHI: OBSERVATIONS ON A
SERIES OF FIFTY CASES.*

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When a foreign body of vegetable origin is aspirated into the air passages of young children an intense and generalized tracheobronchitis very quickly occurs. This inflammation is of an edematous and suppurative character and is accompanied by severe systemic toxemia. These cases, if untreated, usually progress rapidly to a fatal termination. Some cases have been reported in which death occurred from toxemia, even after the early and skillful removal of the foreign body. The clinical picture is in striking contrast to the conditions found following the aspiration of metallic foreign bodies. In such cases the symptoms usually are limited to those produced by mechanical interference with function, and the pathologic changes are confined to the affected bronchus and the portion of the lung aerated and drained by it.

The inflammatory reaction of the trachea and bronchi to the presence of vegetable matter was noted first by Patterson in children who had aspirated peanuts, and arachidic bronchitis, from *Arachis hypogaea*, the botanical name of the peanut, was suggested by Rosenbloom, and adopted by Jackson, to denote the condition. Later it was observed by Jackson¹ that a similar reaction usually was produced by the aspiration of any sort of vegetable substance, and he suggested the term vegetal bronchitis as being more inclusive and more truly descriptive.

Several theories have been suggested as to the exact etiologic factors involved in the production of this type of septic bron-

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chitis. While, without doubt, infection and local trauma play at least a secondary part, the studies of Taylor² regarding sand spurs, and the recent experimental work of Heatley and Clausen³ with peanut bronchitis in rabbits, indicate that the primary cause is some irritant and toxic chemical constituent of the foreign body itself. Age, too, is an important factor, as the symptoms are most severe in children under the age of three, while the condition is rarely seen in adults or in children over the age of twelve.

Because of the severe local and systemic symptoms that characterize vegetal bronchitis and the technical difficulties often encountered in removing vegetable foreign bodies, unanimity of opinion does not prevail as to the best method of treatment. Some laryngologists of skill and experience advise the routine performance of tracheotomy, before attempting removal, in almost all of the cases of this type. The purpose of this report is to submit for consideration, in brief outline, the important clinical features, the treatment and the results obtained in a series of cases in which peroral bronchoscopy, without prior tracheotomy, was the method of treatment employed.

In my series of 148 foreign body cases, fifty of the patients had aspirated vegetable objects. The foreign bodies in question were: thirteen peanut kernels, two pieces of peanut shell, twelve grains of corn (maize), nine watermelon seeds, four pieces of hickory nut shell, four cockleburrs, two orange seeds, one grapefruit seed, one canna seed, one lima bean, one pecan kernel and one piece of potato. The piece of potato was uncooked, and two of the peanuts had not been roasted. All of the hickory nut shells contained portions of the nut kernels as well.

They were located, at the time of bronchoscopy, as follows: six grains of corn, two cockleburrs, two watermelon seeds, one canna seed, one piece of peanut shell, one hickory nut shell and one piece of potato in the trachea; three grains of corn, three watermelon seeds, seven peanut kernels, one peanut shell, two cockleburrs, one hickory nut shell, one pecan kernel, one lima bean and one orange seed in the right bronchus; three grains of corn, four watermelon seeds, six peanut kernels, two hickory nut shells, one orange seed and one grapefruit seed in the left bronchus. One

patient harbored simultaneously two of the foreign bodies: a peanut kernel in the left bronchus, and a flat piece of peanut shell in the right bronchus.

The youngest patient was nine months old and the oldest fifteen years. Thirty-eight of the children were less than four years of age. Thirty-three were boys and seventeen were girls. Forty-one were white and nine were colored. The duration of the cases varied from a few hours to thirty days. In thirty-seven instances the foreign body had been in situ less than one week. In two cases bronchoscopic removal had previously been attempted elsewhere.

In all of the cases a positive or suggestive history was obtained. However, in many it was developed only after questioning, and, in some, after the diagnosis had been made without it, and the foreign body removed. The initial manifestations, incident to the passage of the foreign body through the glottis, were observed and described in a majority of the cases, and consisted of choking, gagging and coughing, usually accompanied by transient dyspnea of varying degree. This stage was followed by a period of comparative comfort and freedom from symptoms, longer in the cases in which the foreign body was fixed in a bronchus than in those in which it remained loose in the trachea. In no instance did this period of quiescence continue longer than twenty-four hours. Then cough, dyspnea, fever and other signs of bronchial irritation and systemic toxemia began to appear. In the following case reports, for the sake of brevity, unimportant details and negative findings have been omitted.

CASE REPORTS.

Case 1. —A white boy, aged $3\frac{1}{2}$ years, while eating peanuts, gagged and choked for a moment, and then began to breathe comfortably again. The following day he began to cough from time to time, and became somewhat short of breath. The symptoms progressively increased in severity. On examination, three days later, the temperature was 103° F., pulse 140 and respiration 45. Cyanosis was slight, and dyspnea was of moderate degree. A distinct asthmatic wheeze could be heard at the mouth. Physical examination of the chest and the roentgenogram showed obstruction of the left bronchus. Without anesthesia, the 5 mm. bronchoscope was introduced. The trachea was intensely inflamed and contained some mucopurulent secretion. After aspiration of the secretion, half a peanut kernel was

found in the left main bronchus. It was removed with side-curved forceps. Recovery gradually occurred without further treatment.

Case 2.—A white girl, aged $3\frac{1}{2}$ years, accidentally aspirated a grain of corn while playing with several grains in her mouth. She did not choke, but began to cough frequently. The cough continued and the voice became somewhat hoarse. On examination, three days later, the temperature was 102° F., pulse 130 and respiration 40. Cough was paroxysmal and of a croupy character. At times, on coughing, a tracheal slap could be heard. Coarse rales were present throughout the chest, but no signs of bronchial obstruction were found. Without anesthesia, the 5 mm. bronchoscope was introduced. The trachea contained a large amount of mucopurulent secretion, and the mucosa was red and slightly edematous. After aspiration of the secretion, a grain of corn was found in the trachea, and removed with side-curved forceps. Recovery followed without further serious symptoms.

Case 3.—A white girl, aged 11 months, began to choke while playing on the floor. In a few moments she was breathing better, but continued to have some dyspnea. On examination, two hours later, dyspnea was the most striking symptom. There was also a tracheal thud on coughing, and the expiratory blast, at times, was checked during crying. Without anesthesia, the laryngeal speculum was introduced, and a canna seed was found in the trachea, just below the vocal cords. It moved up and down with respiration. It was removed with alligator forceps without introducing the bronchoscope. The dyspnea was relieved at once and there were no further symptoms. In this case the symptoms were due entirely to the relative size of the foreign body, as no inflammatory reaction had occurred.

Case 4.—A white girl, aged 4 years, suddenly stumbled and caught her breath, while running with several grains of corn in her mouth. She coughed and choked for a moment, and then continued at play. Soon she began to cough, at first occasionally, but later with frequent paroxysms. On examination, eighteen hours after the accident, the temperature was 100° F., pulse 120 and respiration 40. The voice was hoarse, and cough was paroxysmal and croupy. A wheeze could be heard at the mouth when she was breathing quietly. Examination of the chest was negative except for numerous rales which were heard throughout. Without anesthesia, the 5 mm. bronchoscope was introduced. A moderate amount of secretion was aspirated. A grain of corn was found loose in the trachea and removed with forward-grasping forceps. The symptoms subsided quickly and complete recovery followed.

Case 5.—A white girl, aged 3 years, strangled while eating pecans. The following day she began to cough at intervals, and became quite fretful. The symptoms gradually grew worse, fever developed, and it was thought that she had pneumonia. A physician suggested the probability of foreign body aspiration, but the parents refused immediate treatment, hoping that the foreign body, if present, soon would be coughed up. On examination, ten days after the initial symptoms, the temperature was 103.2° F., pulse 150 and respiration 45. Cyanosis and dyspnea were quite noticeable, and the patient seemed fairly ill. There was a moderate amount of coughing. An intermittent wheeze was heard at the mouth. Physical and roentgen ray examination showed obstructive emphysema of the right lung. Without anesthesia, the 5 mm. bronchoscope was introduced. A severe tracheo-bronchitis with moderate edema of the mucous membrane was present. A

small amount of thick secretion was aspirated. A large piece of pecan kernel was found in the right main bronchus and removed with side-curved forceps. A small piece of pecan kernel was coughed up two hours later. The dyspnea and other symptoms subsided gradually and complete recovery ensued.

Case 6.—A colored girl, aged 4 years, was seen to cough and choke for a few moments while eating roasted peanuts. She continued to cough at intervals. On examination, four hours later, there were no signs of systemic infection. However, the physical signs showed partial obstruction of the right main bronchus. Roentgen ray examination was not made. Without anesthesia, the 5 mm. bronchoscope was introduced. A small amount of secretion was present in the trachea. A peanut kernel was found in the right main bronchus and removed with side-curved forceps. Prompt recovery followed. In this case the condition was recognized and treatment sought before the development of any serious symptoms.

Case 7.—A colored boy, aged $2\frac{1}{2}$ years, gagged, choked and coughed while eating watermelon, and was thought to have aspirated a seed. The cough continued and grew more frequent and severe. On examination, six hours later, many coarse rales were heard throughout the chest, but there were no signs of bronchial obstruction. At times, on coughing, a tracheal slap could be heard. Without anesthesia, the 5 mm. bronchoscope was introduced. A moderate amount of secretion was aspirated. A watermelon seed was found at the right bronchial orifice and removed with forward-grasping forceps. The child was discharged well on the following day.

Case 8.—A white boy, aged 14 months, while playing with potato peelings, began to cough and choke, and remained somewhat short of breath. Breathing gradually became still more difficult. On examination, eight hours after the initial symptoms, there was definite cyanosis, and dyspnea was extreme. The temperature was 101° F., pulse 150 and respiration 65. There was some indrawing of the supraclavicular and epigastric areas. Without anesthesia, the laryngeal speculum was inserted, and a piece of potato was found in the subglottic trachea. A well established subglottic edema was present. The potato was removed with alligator forceps without introducing the bronchoscope. A moderate amount of tracheal secretion was aspirated. The breathing became better immediately, but, four hours later, the dyspnea began to grow worse again. Reexamination showed the subglottic edema to have increased. After some further observation, a low tracheotomy was done, and a No. 1 Jackson tube inserted. The convalescence was stormy. It became necessary to remove thick plugs and crusts from the trachea and bronchi on six occasions. However, decannulation was accomplished on the tenth day, and complete recovery followed.

Case 9.—A white boy, aged 3 years, had coughed frequently for two days, and, at times, had been short of breath. He had been playing with some corn just before the symptoms commenced. On examination the temperature was 101.2° F., pulse 130 and respiration 35. His voice was somewhat hoarse and he was having occasional paroxysms of croupy cough. An intermittent wheeze could be heard at the mouth, and a tracheal slap was heard on coughing. Physical examination of the chest showed numerous rales, but no signs of bronchial obstruction. Roentgen ray examination was not made. Without anesthesia, the 5 mm. broncho-

scope was introduced. There was present a well established tracheitis with mucopurulent secretion. After aspiration of the secretion, a grain of corn was found loose in the trachea. It was removed with forward-grasping forceps. The hoarseness and cough continued for a few days, after which complete recovery occurred.

Case 10.—A colored boy, aged 2 years, coughed and gagged for a few minutes while cracking some peanut shells with his teeth. The next day he coughed frequently, became restless and fever developed. On examination, three days after the accident, the temperature was 104.2° F., pulse 150 and respiration 50. Cyanosis and dyspnea were severe, and there were occasional attacks of coughing. An intermittent wheeze was heard at the mouth on expiration. The physical signs and the roentgenogram were typical of obstructive emphysema of the right lung. The child seemed to be quite ill. Without anesthesia, the 5 mm. bronchoscope was introduced. An intense tracheitis with severe subglottic edema was present. A large piece of peanut kernel was found in the right main bronchus and removed with side-curved forceps. A fairly large amount of secretion was aspirated. Following the bronchoscopy, the dyspnea gradually increased, and, twelve hours later, a low tracheotomy was done and a No. 2 Jackson tube inserted. The patient promptly coughed up a large amount of mucopurulent material. Then he became more comfortable and his condition improved rapidly. Decanulation was done on the fifth day after which the convalescence was uneventful.

Case 11.—A white boy, aged 2 years, aspirated a seed while eating watermelon. He gagged and choked for a moment, and then had no further symptoms for a time. In a few hours he began to cough, and the cough at times was paroxysmal. On examination two days later the temperature was 101.2° F., pulse 130 and respiration 40. There was slight dyspnea, but no wheeze or tracheal slap was heard. Physical examination of the chest showed partial obstruction of the right main bronchus. The roentgen ray examination was negative. Without anesthesia, the 5 mm. bronchoscope was introduced. A moderate degree of tracheobronchitis was present. The secretion was aspirated and a watermelon seed was found in the right main bronchus. It was removed with side-curved forceps. Recovery followed without further serious symptoms. This foreign body remained loose in the trachea for several hours following its aspiration.

Case 12.—A white boy, aged 2½ years, choked for a moment while eating watermelon. Then he began to cough frequently, became fretful, and breathed with increasing rapidity. On examination, three days after the initial symptoms, the temperature was 101° F., pulse 140 and respiration 45. Cyanosis was slight, dyspnea was moderate, and there were occasional paroxysms of coughing. An intermittent wheeze could be heard at the mouth. The physical signs and the roentgenogram were suggestive of partial obstruction of the left bronchus. Without anesthesia, the 4 mm. bronchoscope was introduced. Moderate subglottic edema and a definite tracheobronchitis were present. After aspiration of the secretion, a watermelon seed was found in the left bronchial orifice. It was removed with forward-grasping forceps. Except for a croupy cough, which persisted for several days, the convalescence was uneventful.

Case 13.—A white boy, aged 4 years, aspirated a seed while eating watermelon. He choked for a moment, then began to cough with increasing

frequency. On examination, twenty-four hours later, there were no signs of systemic toxemia. However, the boy was somewhat hoarse, and he had a croupy cough. At times when he coughed a distinct tracheal thud could be felt. Physical examination of the chest showed numerous coarse rales and audible tracheal slap, but no signs of bronchial obstruction. Roentgen ray examination was not made. Without anesthesia, the 5 mm. bronchoscope was introduced. The trachea was inflamed and contained a large amount of frothy secretion. It was removed by aspiration. A watermelon seed was found loose in the trachea and removed with side-curved forceps. Recovery occurred without further treatment.

Case 14.—A white boy, aged 2 years, choked for a moment while eating a piece of toast. He apparently expectorated all of the toast and had no further symptoms at the time. Just previously, he had been playing on the kitchen floor while breakfast was being prepared. The following day he began to cough and became quite fretful. His condition was thought to be due to a cold, but the symptoms grew more pronounced from day to day and, finally, he was brought to the hospital for study. On examination, ten days after the initial symptoms, the temperature was 101° F., pulse 130 and respiration 40. He had an intermittent cough and slight dyspnea, but did not show much evidence of toxemia. A faint wheeze could be heard at the mouth on expiration. Physical and roentgen ray examinations showed typical obstructive emphysema of the right lung. Without anesthesia, the 4 mm. bronchoscope was introduced. A moderate degree of tracheobronchitis was present. The secretion was aspirated and a grapefruit seed was found impacted in the left main bronchus. It was removed with side-curved forceps. After four days, during which time there was slight hoarseness and an occasional attack of coughing, the patient was discharged well. This child evidently had placed a grapefruit seed in his mouth while playing on the floor and aspirated it when he began to eat the toast.

Case 15.—A white girl, aged 2½ years, while playing with seed corn, put several grains in her mouth. Shortly afterwards she choked and coughed and became quite blue. In a few moments she began to breathe normally again. The following day she coughed occasionally, had fever and was restless. She was referred then for examination. The temperature was 101.3° F., pulse 125 and respiration 40. There was slight dyspnea, but no cyanosis nor wheeze. Physical and roentgen ray examinations showed obstructive emphysema of the right lung. Without anesthesia, the 5 mm. bronchoscope was introduced. A moderate degree of tracheobronchitis was present. A grain of corn was found in the right main bronchus and removed with side-curved forceps. The pentup secretion was removed by aspiration. The patient was discharged the following day and recovery was soon complete. This foreign body apparently became fixed in the bronchus immediately after its aspiration.

Case 16.—A white boy, aged 2½ years, began to have frequent attacks of coughing while playing alone outdoors. Soon he developed a noticeable stridor on breathing. On examination, fifteen hours later, his general condition seemed good, but he was having definite dyspnea, and his voice was decidedly hoarse. Physical examination showed many coarse rales throughout the chest, but no signs of bronchial obstruction. Roentgen ray examination was negative. Without anesthesia, the larynx was

examined and found to be slightly inflamed, but no membrane was present. The 4 mm. bronchoscope was introduced. There was a moderate subglottic edema and the trachea was quite inflamed. After aspiration of the secretion, a grain of corn was found loose in the trachea. It was removed with side-curved forceps. Prompt recovery ensued without further treatment.

Case 17.—A white girl, aged 15 months, was seen to aspirate a peanut kernel while playing on the floor. The parents thought it would be coughed up. Twelve hours later she began to have fever, coughed at intervals and became quite restless. On examination, thirty-six hours after the accident, the child appeared very ill. She was poorly nourished and showed definite signs of rickets. The temperature was 105° F., pulse 150 and respiration 60. Cyanosis and dyspnea were both severe. Physical and roentgen ray examination showed obstruction of the left bronchus. Without anesthesia, the 4 mm. bronchoscope was introduced. The trachea was intensely inflamed and contained some pink mucopurulent secretion. After aspiration of the secretion, half of a peanut kernel was found in the left main bronchus. It was removed with side-curved forceps and the retained secretion was aspirated. Gradual recovery followed without the necessity of further treatment.

Case 18.—A white boy, aged 18 months, suddenly began to cough and choke while playing with shelled corn. The cough at first was frequent and paroxysmal, but later became less severe. Fever and difficult breathing soon were noticed. On examination, four days after the initial symptoms, the baby's face was pale and his appearance suggested toxemia. The temperature was 103.2° F., pulse 140 and respiration 50. There was occasional cough, and dyspnea was severe. Physical and roentgen ray examinations showed complete obstruction of the left main bronchus. Without anesthesia, the 4 mm. bronchoscope was introduced. The trachea was inflamed and there was some mucosal edema. A grain of corn was found tightly impacted in the left main bronchus. It was removed with side-curved forceps and the pentup secretion was aspirated. Some cough, hoarseness and dyspnea continued for several days, after which complete recovery ensued.

Case 19.—A white girl, aged 4 years, coughed and choked while eating hickory nuts. The following day she complained of a slight pain in her chest, coughed frequently and the sputum was bloodstained. A diagnosis of pneumonia was made. After several weeks of illness without improvement, the initial symptoms and the attending circumstances were recalled. Then the probability of foreign body aspiration became apparent. On examination one month after the accident, the temperature was 102° F., pulse 130 and respiration 40. Cyanosis was slight, but dyspnea was of moderate degree. A faint wheeze could be heard at the mouth. Physical and roentgen ray examinations showed obstruction of the right bronchus below the upper lobe branch. Without anesthesia, the 5 mm. bronchoscope was introduced. The trachea was quite red, and a considerable amount of foul mucopurulent secretion was present. After aspiration of the secretion, a piece of hickory nut shell was found impacted in the right stem bronchus. There were some granulations around it. After clipping off the granulations, the shell was removed with side-curved forceps. Some hoarseness and dyspnea persisted for several days.

However, the lung gradually returned to normal and complete recovery occurred.

Case 20.—A white boy, aged 18 months, picked up and aspirated a watermelon seed while playing on the floor. Frequent paroxysms of coughing followed. On examination twenty-four hours later he showed no signs of systemic toxemia, but had mild dyspnea and a definitely croupy cough. At times, on coughing, a tracheal slap could be heard. Physical examination of the chest showed numerous coarse rales but no signs of bronchial obstruction. Roentgen ray examination was not made. Without anesthesia, the direct laryngoscope was inserted, and a watermelon seed was found in the upper trachea, just below the vocal cords. It was removed with alligator forceps without introducing the bronchoscope. The dyspnea subsided rapidly and complete recovery followed.

Case 21.—A colored boy, aged 6 years, while cracking hickory nuts with his teeth, aspirated a piece of the shell. He gagged and choked for a moment, and then felt all right again. Soon he began to cough occasionally and complained of some pain in his chest. The cough continued and some fever and shortness of breath developed. On examination, one week after the accident, the temperature was 101.3° F., pulse 120 and respiration 40. Cyanosis was absent but dyspnea was of moderate degree. Physical and roentgen ray examinations showed almost complete obstruction of the left bronchus. Without anesthesia, the 5 mm. bronchoscope was introduced. Some mucopurulent secretion was aspirated from the trachea. A piece of hickory nut shell was found impacted in the left main bronchus. It was removed with side-curved forceps and the pentup secretion was aspirated. Complete recovery followed without further serious symptoms.

Case 22.—A white boy, aged 6 years, aspirated a piece of hickory nut shell. He was trying to suck the kernels from some hickory nut shells at the time. After gagging and choking a moment, he began to breathe normally again. In a few hours he began to have frequent attacks of coughing, and became quite hoarse. On examination, three days after the accident, the temperature was 100° F., pulse 120 and respiration 40. Cough was frequent and croupy, cyanosis was slight and dyspnea was of moderate degree. Numerous rales and harsh breath sounds could be heard throughout the chest but there were no signs of bronchial obstruction. Roentgen ray examination was not made. Without anesthesia, the 5 mm. bronchoscope was introduced. A moderate subglottic edema was present, and the trachea was very red and contained a large amount of thick secretion. After aspiration of the secretion, a large piece of hickory nut shell was found in the trachea lying across the carina. It was removed with forward-grasping forceps. The cough and dyspnea subsided gradually and complete recovery occurred.

Case 23.—A white girl, aged 19 months, choked for a moment while eating pear nut candy. In a few hours she began to cough and became quite fretful. On examination, twenty-four hours after the initial symptoms, she was breathing with noticeable difficulty, and was slightly cyanotic. At intervals a faint wheeze could be heard at the mouth. The temperature was 102.3° F., pulse 140 and respiration 45. Physical examination of the chest and roentgenogram showed typical obstructive emphysema of the right lung. Without anesthesia, the 4 mm. bronchoscope was introduced.

The trachea was inflamed and a small amount of slightly pink secretion was present. A portion of a peanut kernel was found in the right main bronchus and removed with side-curved forceps. The secretion was removed by aspiration. Convalescence was uneventful except for the continuance of slight dyspnea and hoarseness for several days.

Case 24.—A white boy, aged 7 years, choked while eating peanuts. Almost at once he began to cough frequently and breathe noisily. The following day, the symptoms having grown more pronounced, a diagnosis of laryngeal diphtheria was made, and antitoxin was given. No improvement followed, and the child's condition gradually grew worse from day to day. The possibility of foreign body aspiration was recalled and bronchoscopic examination sought. On examination, seventeen days after the initial symptoms, the temperature was 103.2° F., pulse 150 and respiration 55. The skin was pale, the breathing was quite rapid and difficult, and a fairly loud stridor was heard constantly. Occasional paroxysms of coughing occurred. The breath was noticeably foul. Physical examination showed numerous coarse rales but no signs of bronchial obstruction. Roentgen ray examination was not made. Without anesthesia, the 5 mm. bronchoscope was introduced. The trachea was intensely inflamed and contained some thick mucopurulent secretion. Midway between the glottis and the bifurcation of the trachea, a flat piece of peanut shell was found tightly impacted across the lumen. It was removed with side-curved forceps and the secretion was aspirated. The dyspnea and other symptoms began to improve the following day, and recovery ensued without further treatment.

Case 25.—A white girl, aged 3 years, was playing with seed corn and aspirated a grain while running about. In a few hours she began to have rapid breathing and a croupy cough. On examination, two days later, the temperature was 102° F., pulse 130 and respiration 40. The cough was frequent and definitely croupy. At times, on coughing, a tracheal slap and palpatory thud were noted. Physical examination of the chest showed loud breath sounds and coarse rales over both lungs. Roentgen ray examination was negative. Without anesthesia, the 5 mm. bronchoscope was introduced. There was some subglottic edema and the entire tracheal mucosa was severely inflamed. After aspiration of the secretion, a grain of corn was found in the left main bronchus. It was not impacted. It was removed with side-curved forceps. Recovery occurred without further treatment. In this case the foreign body undoubtedly had been loose in the trachea most of the time.

Case 26.—A white boy, aged 2½ years, had been playing in a field. He came home crying and somewhat short of breath. A short time later he began to cough with increasing frequency, and breathing became noisy. On examination, twenty-four hours after the onset of the symptoms, he was croupy and fretful, but there were no signs of systemic toxemia. He was having moderate dyspnea and an asthmatic wheeze could be heard occasionally. There was no slap nor thud. Physical examination showed a few rales over both lungs. Roentgen ray examination was not made. Without anesthesia, the laryngeal speculum was inserted. A moderate degree of subglottic edema was present. A small cockle burr was found lying across the lumen in the subglottic trachea. It was removed with

alligator forceps without introducing the bronchoscope. A small amount of frothy tracheal secretion was removed by aspiration. The dyspnea subsided rapidly and prompt recovery followed.

Case 27.—A white boy, aged 9 months, suddenly coughed and choked while playing on the floor. The urgent dyspnea subsided quickly, but some stridor and rapid breathing continued. On examination, twelve hours later, the child had some cyanosis and dyspnea, but showed no signs of systemic illness. Cough was frequent and croupy. A tracheal slap could be heard at times. There were no signs of bronchial obstruction. Roentgen ray examination was not made. Without anesthesia, the direct laryngoscope was introduced. A watermelon seed was found in the trachea just below the glottis. It moved up and down with respiration. It was removed with alligator forceps without introducing the bronchoscope. Complete recovery followed without the necessity of further treatment.

Case 28.—A colored boy, aged 3 years, suddenly began to have a peculiar wheeze on breathing, coughed frequently and seemed fretful. After much questioning, it was learned that he had been eating peanuts just before the symptoms commenced. On examination, two days later, the temperature was 102.3° F., pulse 140 and respiration 45. There was moderate dyspnea and an occasional irritative cough. An intermittent wheeze could be heard at the mouth. Physical and roentgen ray examinations showed the typical signs of obstructive emphysema of the right lung. Without anesthesia, the 5 mm. bronchoscope was introduced. There was a small quantity of pink mucopurulent secretion in the trachea, and the mucosa was inflamed and somewhat edematous. Half of a peanut kernel was found in the right main bronchus and removed with side-curved forceps. The secretion was removed by aspiration. Hoarseness and mild dyspnea persisted for a few days, after which complete recovery occurred.

Case 29.—A white boy, aged 6 years, accidentally aspirated a cockle burr when he sucked his finger tip to which the burr had become attached. He coughed and choked for a few minutes, then had no further symptoms for a time. He reported the accident to his parents, but they delayed seeking treatment, hoping that the foreign body would be coughed up. The following day he coughed at intervals, had fever and became slightly short of breath. On examination, three days after the accident, the temperature was 101° F., pulse 110 and respiration 35. He was having occasional paroxysms of coughing, and complained of some pain in the right side of his chest. Physical examination showed the area over the middle and lower lobes of the right lung to be flat and devoid of breath sounds. The roentgenogram showed a dense shadow over the same area. With ether anesthesia, the 6 mm. bronchoscope was introduced. A small amount of secretion was aspirated from the trachea. A large cockle burr was found impacted in the right bronchus just below the upper lobe branch. It was removed with stiff side-curved forceps. After removal of the foreign body, a large amount of secretion was aspirated from the bronchus. The lung gradually returned to normal and complete recovery ensued.

Case 30.—A colored girl, aged 3 years, while sucking an orange, had a sudden paroxysm of coughing, and became quite short of breath. In a few moments she began to breathe normally, but the cough persisted and her voice became somewhat hoarse. On examination, twenty-four hours

after the initial symptoms, she seemed well except for the respiratory symptoms. Her voice was hoarse, cough was frequent and croupy, and at times a tracheal thud could be felt. Loud rales could be heard throughout the chest, but there were no signs of bronchial obstruction. Without anesthesia, the 5 mm. bronchoscope was introduced. The trachea was inflamed and contained a moderate amount of secretion. After aspiration of the secretion, an orange seed was found in the right bronchial orifice. It was removed with side-curved forceps. The convalescence was uneventful.

Case 31.—A white boy, aged 19 months, choked while playing with some grains of corn. He coughed frequently for several hours. Then he became fretful and began to breathe with increasing rapidity. On examination, twenty-four hours after the accident, the temperature was 102.3° F., pulse 140 and respiration 45. There was light cyanosis and dyspnea was severe. A faint wheeze could be heard on expiration. Physical and roentgen ray examination indicated partial obstruction of the right bronchus. Without anesthesia, the 4 mm. bronchoscope was introduced. A severe tracheobronchitis was present. After aspiration of the secretion, a grain of corn was found in the right main bronchus. It was removed with side-curved forceps. Hoarseness and dyspnea continued for a few days, after which complete recovery occurred.

Case 32.—A white boy, aged 13 years, aspirated a peanut kernel while running and eating peanuts at the same time. His parents delayed treatment in the hope that it would be coughed up. He had a cough, at times severe, from the first day. On the third day he began to feel ill and had fever. On examination, ten days after the accident, the temperature was 101.3° F., pulse 120 and respiration 35. He was having occasional attacks of productive cough with foul sputum. Physical and roentgen ray examination showed typical obstructive emphysema of the middle and lower lobes of the right lung. With ether anesthesia, the 6 mm. bronchoscope was introduced. A moderate degree of tracheobronchitis was present. Half a peanut kernel was found in the right stem bronchus and removed with stiff side-curved forceps. A fairly large quantity of pent-up secretion was removed by aspiration. Complete recovery followed an uneventful convalescence.

Case 33.—A white girl, aged 10 years, accidentally sucked a cockle burr from her finger tip and aspirated it. Almost immediately she became hoarse and began to cough frequently. The symptoms continued without abatement. On examination, two days later, there were no definite signs of toxemia. However, the voice was quite hoarse and dyspnea was of moderate degree. Cough was frequent and croupy. There were no signs of bronchial obstruction. Without anesthesia, the direct laryngoscope was inserted. A cockle burr was found in the subglottic trachea, just below the vocal cords. It was removed with alligator forceps. The hoarseness continued for several days, but recovery occurred without further treatment.

Case 34.—A white boy, aged 3 years, gagged and choked for a few minutes while eating watermelon. The following day he had slight fever and began to cough at intervals. His parents noticed a faint wheeze when he was breathing quietly. On examination, two days after the initial symptoms, the temperature was 102° F., pulse 120 and respiration 40. Cough

was fairly frequent and definitely croupy. An occasional tracheal slap could be heard. Physical examination showed numerous loud ra'es over both lungs, but no signs of bronchial obstruction. Roentgen ray examination was not made. Without anesthesia, the 5 mm. bronchoscope was introduced. A moderate subglottic edema was present and there was a considerable amount of secretion in the trachea. After aspiration of the secretion, a watermelon seed was found in the right bronchial orifice. It was removed with side-curved forceps. Complete recovery occurred without further serious symptoms.

Case 35.—A colored boy, aged 2½ years, began to be restless and short of breath four days before admission. It was at first thought that he had a cold, but a physician found signs suggestive of foreign body aspiration. On examination the temperature was 103.2° F., pulse 150 and respiration 50. The child was very dyspneic and seemed quite ill. Physical and roentgen ray examinations showed obstruction of the right bronchus. Without anesthesia, the 5 mm. bronchoscope was introduced. A severe tracheobronchitis with pink mucopurulent secretion was found. The secretion was aspirated and part of a peanut kernel was found in the right main bronchus. It was removed with side-curved forceps. The fever and dyspnea gradually subsided and complete recovery ensued.

Case 36.—A white boy, aged 15 years, while running after a horse in a pasture, felt something fly into his mouth. He was breathing rapidly, and with his mouth open at the time. He coughed several times and began to feel as if something was in his windpipe. On examination, eight hours later, he complained of pain and a peculiar feeling in the right side of his chest on deep inspiration. On examination with the mirror, the vocal cords were red and appeared to have been irritated. Roentgen ray examination was negative, but physical examination indicated partial obstruction of the right stem bronchus. With ether anesthesia, the 6 mm. bronchoscope was introduced. No noticeable tracheitis was present. A large cocklebur was found fixed in the right bronchus, just below the upper lobe branch. It was removed with stiff side-curved forceps. The patient was discharged well the following day. In this case the cocklebur evidently had been kicked into the air by the running horse and, by chance, had entered the mouth of the boy as he followed.

Case 37.—A white boy, aged 2 years, had been somewhat hoarse, fretful and subject to frequent attacks of coughing for about ten days before admission. For several days he had had fever, and pneumonia was considered the probable diagnosis. Before the onset of the symptoms he had been playing with some children who were eating peanuts. On examination the temperature was 103.4° F., pulse 150 and respiration 50. The child was weak and seemed quite ill. He had moderate dyspnea and noticeable cyanosis. A faint wheeze could be heard at the mouth after coughing. Physical and roentgen ray examinations showed obstruction of the left main bronchus. Without anesthesia, the 4 mm. bronchoscope was introduced. A moderate amount of foul mucopurulent secretion was aspirated from the trachea. A piece of peanut shell was found in the left bronchus and removed with side-curved forceps. Further search did not reveal any fragments of peanut kernel. The patient continued to be slightly hoarse and dyspneic for forty-eight hours, but recovered completely without further treatment.

Case 38.—A colored boy, aged 2 years, gagged, coughed and choked for a few minutes while eating peanut candy. The accident was observed but his parents did not realize that a foreign body had been aspirated. The next day he continued to cough and had fever. The symptoms grew worse, and a diagnosis of pneumonia was made. Later, when a crisis did not occur, further examination and discussion of the history suggested the presence of a foreign body. On examination, two weeks after the initial symptoms, the temperature was 101° F., pulse 140 and respiration 50. Dyspnea was fairly severe, and the child was poorly nourished and seemed to be quite ill. Physical examination of the chest showed complete obstruction of the left main bronchus. The roentgenogram indicated consolidation of the entire left lung. Without anesthesia, the 4 mm. bronchoscope was introduced. A small amount of thick secretion was aspirated from the trachea. Half of a peanut kernel was found tightly impacted in the left main bronchus. It was removed with side-curved forceps. Six hours later the patient began to breathe with more difficulty, and numerous loud rales could be heard throughout the chest. The larynx was examined with a speculum and severe subglottic edema was found. During this examination some foul, thick secretion was aspirated from the trachea. The dyspnea gradually grew worse and, fourteen hours after the bronchoscopy, a low tracheotomy was done and a No. 2 Jackson tube inserted. Improvement was immediate, and a large quantity of secretion was coughed out in the next forty-eight hours. The patient was decannulated on the sixth day and complete recovery followed.

Case 39.—A white boy, aged 2 years, was seen to choke while holding some grains of corn in his mouth, six hours before admission. Since then he had had several attacks of coughing. On examination the temperature was normal, but the pulse was somewhat rapid and there was moderate dyspnea. Cough was paroxysmal and croupy. Physical examination showed some rales throughout the chest and the breath sounds were loud and harsh. No wheeze nor tracheal slap could be heard. Roentgen ray examination was not made. Without anesthesia, the 4 mm. bronchoscope was introduced. The trachea was inflamed and contained a moderate amount of secretion. After aspiration of the secretion, a grain of corn was found in the left bronchial orifice. It was removed with side-curved forceps. The patient was discharged the following day and complete recovery followed.

Case 40.—A white girl, aged 11 months, had had a croupy cough, and had been short of breath and fretful for three weeks before admission. There was no definite history of foreign body aspiration. On examination the temperature was 103.2° F., pulse 140 and respiration 45. She had a hoarse, croupy cough and a moderate degree of dyspnea. An intermittent tracheal slap could be heard. Physical examination showed coarse rales throughout the chest but no bronchial obstruction. Roentgen ray examination was negative. Without anesthesia, the 4 mm. bronchoscope was introduced. A severe tracheitis was present. After aspiration of the secretion a small grain of corn was found loose in the trachea. It was removed with forward-grasping forceps. There was a slight increase in dyspnea for twenty-four hours following the bronchoscopy. Then the symptoms subsided and recovery took place without further treatment.

Case 41.—A white boy, aged $4\frac{1}{2}$ years, while playing with seed corn, put several grains in his mouth. While running, he stumbled and then began to cough and choke. The following day his cough was severe and he began to breathe with increasing rapidity. On examination, three days after the initial symptoms, the temperature was 102.3° F., pulse 140 and respiration 50. There was moderate cyanosis, and dyspnea was quite severe. Cough was frequent and croupy. A loud wheeze could be heard on inspiration and expiration. Physical examination showed numerous coarse rales over both lungs, but no obstruction of the bronchi. Roentgen ray examination was not made. Without anesthesia, the 5 mm. bronchoscope was introduced. There was a very severe subglottic edema present, and the entire trachea was quite inflamed. Much mucopurulent secretion was aspirated. A grain of corn was found in the left bronchial orifice. It was removed with side-curved forceps. Shortly after the bronchoscopy the dyspnea became worse for a time. However, the dyspnea subsided without further treatment and complete recovery occurred. In this case the foreign body evidently had been loose in the trachea most of the time.

Case 42.—A white boy, aged 2 years, choked and coughed severely while eating watermelon five days before admission. The cough continued and paroxysms occurred frequently during the next two days. Then he became fretful, and had irregular fever, but did not cough so much. On examination the temperature was 102° F., pulse 140 and respiration 45. There was slight cyanosis and dyspnea was of moderate degree. Physical and roentgen ray examinations indicated partial obstruction of the left bronchus. Without anesthesia, the 5 mm. bronchoscope was introduced. A well established tracheobronchitis was present. After aspiration of some mucopurulent secretion, a watermelon seed was found in the left main bronchus. It was removed with side-curved forceps. The symptoms gradually subsided and complete recovery occurred.

Case 43.—A colored boy, aged 4 years, while eating hickory nuts, gagged and choked and aspirated a piece of shell. He began to cough frequently. He reported the accident to his parents who sought treatment promptly. On examination, twenty-four hours later, the temperature was normal, and there were no systemic symptoms of consequence. Cough was fairly frequent, but not paroxysmal. Physical examination showed partial obstruction of the left bronchus. Roentgen ray examination was not made. Without anesthesia, the 5 mm. bronchoscope was introduced. A moderate amount of secretion was aspirated. A piece of hickory nut shell was found in the left main bronchus and removed with side-curved forceps. Recovery was prompt and complete.

Case 44.—A white boy, aged $2\frac{1}{2}$ years, aspirated a seed while eating watermelon. The accident was observed, but the parents hoped that the seed would be expelled spontaneously. On examination, five days after the accident, the temperature was 102.3° F., pulse 130 and respiration 45. Cyanosis was absent, but there was a fair amount of dyspnea, especially after coughing. A wheeze could be heard at times. Cough occurred in occasional paroxysms. Physical examination showed partial obstruction of the left bronchus. Roentgen ray examination was negative. With ether anesthesia, the 5 mm. bronchoscope was introduced. A moderate tracheobronchitis with considerable secretion was present. After aspiration of the secretion, a watermelon seed was found, not impacted, lying in the left

main bronchus. It was removed with side-curved forceps. Uneventful recovery followed.

Case 45.—A white girl, aged 2 years, began suddenly to cough, became fretful, and had fever ten days before admission. The following day her condition became worse, and a diagnosis of pneumonia was made. After a week, because of the atypical clinical picture, the possibility of foreign body aspiration was inquired into and considered. On admission to the hospital the temperature was 104° F., pulse 150 and respiration 55. There was definite cyanosis and dyspnea was severe. A faint wheeze could be heard at the mouth. There was occasional cough and the breath was foul. Physical and roentgen ray examinations showed obstructive emphysema of the left lung. Without anesthesia, the 5 mm. bronchoscope was introduced. A moderate amount of thick mucopurulent secretion was aspirated from the trachea. Half of a peanut kernel was found in the left main bronchus with annular edema partially covering it. It was removed with side-curved forceps, and the pentup secretion was aspirated. The patient was hoarse and had moderate dyspnea for four days, after which complete recovery occurred.

Case 46.—A white boy, aged 20 months, choked while eating peanuts two weeks before admission. Several chewed up fragments of peanut were taken from his mouth at the time. The parents did not believe any had been aspirated. The following day he began to cough frequently and had fever. It was thought that he had pneumonia. The general symptoms, while somewhat intermittent, remained severe, and the parents decided that aspiration of a piece of peanut probably had occurred. On examination the child was pale, cyanotic and apparently quite ill. The temperature was 104.2° F., pulse 150 and respiration 50. Physical and roentgen ray examinations showed complete obstruction of the left main bronchus. Without anesthesia, the 4 mm. bronchoscope was introduced. The trachea was quite inflamed and contained some thick secretion. The mucosa of the left bronchus was very much swollen. Three peanut fragments were found wedged in the almost obliterated lumen. They were removed with side-curved forceps, and a large amount of pentup secretion was removed by aspiration. Twelve hours later the temperature, which was verified carefully, was 108.2° F. Dyspnea was slight, but the toxemia seemed most intense. The larynx was exposed with the speculum and some more secretion was aspirated from the trachea. The temperature dropped in a few hours to 103° F., and then gradually came down to normal. On discharge the lung condition was very much better and, at last report, the child apparently was making a complete recovery.

Case 47.—A white girl, aged 20 months, aspirated an orange seed ten days before admission. The accident was observed but the treatment was postponed by the parents in the hope of spontaneous expulsion. She began to have frequent attacks of coughing, at times with blood-tinged sputum, and her breathing gradually grew more difficult. On examination the temperature was 102.4° F., pulse 150 and respiration 60. The voice was hoarse, and cyanosis and dyspnea were severe. There were frequent paroxysms of croupy cough. Physical examination showed numerous rales but no signs of bronchial obstruction. Roentgen ray examination was not made. Without anesthesia, the 4 mm. bronchoscope was introduced. Subglottic edema was severe, and there was an intense generalized tracheitis

present. After aspiration of the secretion, an orange seed was found in the left bronchial orifice. It was removed with forward-grasping forceps. It evidently had been loose in the trachea most of the time since its aspiration. The dyspnea did not show any improvement following bronchoscopy, and, as the heart action began to show signs of exhaustion, a low tracheotomy was done three hours after removal of the foreign body, and a No. 1 Jackson tube inserted. The child became comfortable immediately and the general condition improved rapidly. Decannulation was done on the fifth day, after which complete recovery occurred without further complications.

Case 48.—A white girl, aged 2 years, aspirated a lima bean with which she had been playing. She gagged and choked for a moment, and then began to cough at frequent intervals. After a few hours she stopped coughing but began to breathe more rapidly. On examination, two days after the accident, the temperature was 102° F., pulse 150 and respiration 50. She was definitely cyanotic and her breathing was very shallow. Physical examination showed that no air was entering the middle and lower lobes of the right lung. The roentgenogram showed a shadow over the same region. Without anesthesia, the 5 mm. bronchoscope was introduced. There was only a slight subglottic edema, but a generalized tracheitis with increased secretion was present. The secretion was aspirated, and a bean was found tightly impacted in the right bronchus, just below the upper lobe branch. It was removed with stiff side-curved forceps and the pentup secretion was aspirated from the bronchus. Improvement began immediately and recovery followed without further serious symptoms.

Case 49.—A white girl, aged 3 years, aspirated a grain of corn one week before admission. Several paroxysms of coughing followed. The following day she continued to cough, and began to breathe with a noticeable stridor. The symptoms gradually grew more pronounced. On examination the temperature was 101.2° F., pulse 140 and respiration 50. Cough was paroxysmal and croupy, and the voice was weak and hoarse. There was moderate cyanosis present, and dyspnea was quite severe. Physical examination showed harsh sounds and loud rales over the entire chest, but no bronchial obstruction. Roentgen ray examination was not made. Without anesthesia, the 5 mm. bronchoscope was introduced. There was a severe subglottic edema, and the trachea was intensely inflamed and contained a large amount of mucopurulent secretion. Several small patches of exudate could be seen on the tracheal mucosa. A grain of corn was found lying loose in the trachea. It was removed with side-curved forceps and the secretion was removed by aspiration. After removal of the foreign body, the cough became much less frequent, but the dyspnea gradually grew worse. Twelve hours after the bronchoscopy, a low tracheotomy was done, and a No. 2 Jackson tube inserted. A large quantity of thick secretion was coughed out, and the dyspnea was relieved at once. Decannulation was accomplished on the fourth day and complete recovery followed without further complications.

Case 50.—A white boy, aged 18 months, attempted to shell and eat a peanut. He choked and became quite blue for a moment. Then he began to cough at frequent intervals, and his breathing became quite rapid. On examination, six hours after the initial symptoms, the temperature was

99.4° F., pulse 120 and respiration 50. A faint wheeze could be heard at the mouth on inspiration and expiration. Physical examination showed a few rales over the right lung and complete obstruction of the left main bronchus. Roentgen ray examination was not made. Without anesthesia, the 4 mm. bronchoscope was introduced. The trachea was slightly inflamed and contained a moderate amount of frothy secretion. As the bronchoscope approached the bifurcation, a flat piece of peanut shell was seen in the right bronchial orifice. It was removed with side-curved forceps. The bronchoscope was reinserted and a peanut kernel was found in the left main bronchus. It was removed with side-curved forceps. During the following twenty-four hours the baby continued to have some hoarseness and moderate dyspnea. These symptoms subsided without further treatment and prompt recovery followed.

SUMMARY.

1. In a series of fifty cases, in which vegetable foreign bodies were present in the trachea or bronchi, it was possible to remove all of the foreign bodies by peroral bronchoscopy, and all of the patients recovered.

2. In five cases, after the bronchoscopy, it became necessary to perform a tracheotomy to relieve dyspnea, and to provide better drainage for the profuse and toxic secretion. All of the tracheotomies were done deliberately, no case having required emergency intervention.

3. In cases of vegetal bronchitis it is unnecessary routinely to resort to tracheotomy, either as a pre-bronchoscopic measure of safety or as a means of removing the foreign body. Tracheotomy should always be prepared for, but its performance should await the appearance of a definite indication.

4. Removal of secretion, especially that which has been retained in an occluded bronchus, is an important feature of the treatment and should not be neglected.

5. All vegetable foreign bodies induce more local and systemic reaction than do those of an inorganic nature. When other factors are identical, the toxemia caused by the peanut seems to be the most severe.

6. Foreign bodies that remain loose and movable in the trachea cause more violent symptoms and frequently are more dangerous than those that become fixed in a bronchus. They often cause severe subglottic edema and always present some risk of sudden asphyxiation.

7. A history of coughing, gagging and choking is very suggestive, but regardless of the history the possibility of foreign body aspiration should be given full consideration when examining children whose symptoms suggest a lesion of the lower respiratory tract.

8. Examination with the mirror or the direct laryngoscope should be a routine procedure in all cases of supposed laryngeal diphtheria.

9. The belief is all too prevalent, especially among the laity, that spontaneous expulsion of a foreign body will occur. That fortunate termination occurs so rarely, and early removal is of such great importance, that its possibility should be ignored.

10. The asthmatoïd wheeze, heard at the mouth instead of over the chest wall, and the typical signs of obstructive emphysema, are so nearly pathognomonic of an endobronchial foreign body that the unexplained presence of either justifies the performance of a diagnostic bronchoscopy.

11. The aspiration of vegetable foreign bodies is a relatively common accident, especially in childhood, and the resulting condition is a serious menace to life. However, if subjected to prompt and careful bronchoscopy, followed by attentive after-care, the prognosis is excellent.

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LI.

PNEUMOTYMPANIC VIBRATOR.

JOHN C. LESTER, M. D.,
NEW YORK.

It seems an eon ago since the writer devised a means of motivating, electrically, a modification of Lucae's pressure sound, or probe, by an adjustable eccentric throw attached to a shaft of a small motor. With this device marked therapeutic results were obtained in selected cases and these results duly recorded. Unfortunately, the motor proved a failure and the device was discarded. Even now, with brother's toy trains running and orange squeezers squeezing, electrically, there has been no advance along the lines of an adaptable, reliable motor for scientific or professional purposes as herein indicated.

This being the case, it has seemed wise to try other means to accomplish the same, or nearly the same, results. By adopting a modification, or an adaptation, of the principle of the pneumatic type of vibrator—as represented in the Siegle's pneumatic speculum, or otoscope, or the Delstanche Rarefacteur—the writer has been able to develop a pneumatic vibrator of simple design which will safely accomplish all that can be claimed for either of the above or similar instruments, except perhaps for diagnostic purposes.

The device, herein illustrated, consists of a precision tube about four inches long and one-half inch in thickness (outside diameter). A specially designed piston with terminals recessed at either end so as to fix and retain two imbalanced springs makes up the motivating apparatus, or power plant. Two corrugated nipples at either end of the larger or outside tube, are permanently attached—the device being practically foolproof and indestructible—and are made to receive a three-eighths inch flexible rubber tubing with a special rubber bulb attached at the distal end and an olive shaped vulcanized external meatal tip at the other or proximal end. The vulcanized meatal tip is cushioned with a soft piece

of rubber tubing not only better to occlude the external meatus but also to prevent pain caused by undue pressure.

The complete apparatus, as herein described, makes for a simple and efficient tympanic vibrator which will not only motivate the entire drum membrane in suitable cases but also stimulate the tympanic plexus and possibly mobilize the ossicular chain as well.

By attaching the device to a Siegle's pneumatic speculum or otoscope, the writer has been able actually to observe its action in a given case. Besides it has not only been possible to observe the action of the vibrator but also to note that with one impulse given to the vibrator by the operator there has not been over thirty recoils per minute with resultant positive and negative pressures to the tympanum and adnexa. Of course, the force of the impulse given to the bulb will naturally both increase and decrease the number and force of the recoils, but in no case will it be possible to create more than a pressure estimated at about five pounds—a fact that is due to the limited resilience of the springs and the mechanical limitation of the piston.

Possibly in the dim future some Yankee, smart and undaunted, with a touch of Western naiveté, tinkering in his workshop, may create a simple and efficient motor that will cover the desires or needs of the scientific world along this line, but so far this motor remains remoter and in statu quo.

Indications for the employment of pneumatic massage of the tympanum and adnexa have been so thoroughly standardized by the otologist that any additional suggestions as to this field of aural therapeutics would seem almost superfluous and unnecessary.

However, a brief resumé might not be out of place at this time. As phonetic massage has been generally discarded by the otologist the indications herein are limited to pneumomassage exclusively. Quoting directly from no less an authority than Randall, I am able to supplement my thoughts in his words: "In the first place," he says, "hand power cannot be dangerously rhythmic Message that can be placed in the hands even of a patient may be of great value, as supplementing the treatment by the specialist."

It follows then that in cases of recent or chronic middle ear catarrh, where the lower third of the tympanum can only be motivated by either the Politzerization or the eustachian catheter, slight adhesions of the malleus to the promontory or even a slight ankylosis of the ossicular chain, recent or following operation, can be at least lessened. Even stimulation of the labyrinth in given cases can be accomplished. Besides the various forms of tinnitus aurium, the *bete noire* of the aurist, can be modified and in many cases relieved, depending, of course, on the cause, intensity and duration. In short, as indicated above, this device is simply intended as a simple, inexpensive addition to the otologist's armamentarium in his routine treatment of suitable cases.

The advantages of this device are:

1. *Simplicity*: It can be used by the specialist or general practitioner in suitable cases.
2. *Adaptability*: It can be used in any case requiring aural massage, young or old, with absolute safety, there being at most only about five pounds of positive or negative pressure possible.
3. *Indestructibility*: It will last a lifetime, the working parts being concealed and needing no care or lubrication.
4. *Availability*: It can be used, even by the patient, under the advice of the attending aurist, where frequent visits are impossible or seemingly unnecessary.

666 MADISON AVENUE.

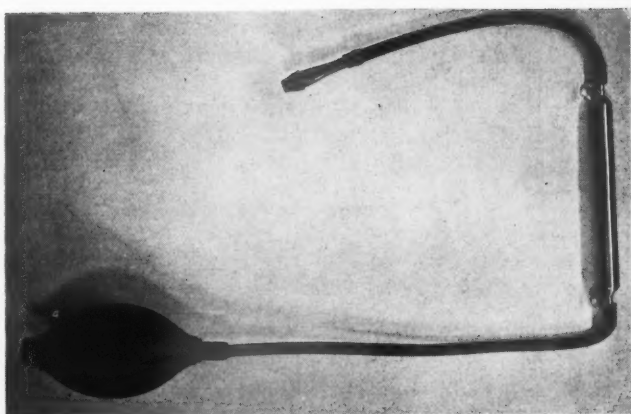


Fig. 1.



Fig. 2.

LII.

AUTOSPINAL FLUID AND COLLOIDAL GOLD IN PURULENT MENINGITIS.*

CLARENCE A. VEASEY, JR., M. D.,

SPOKANE.

Isolated instances of recovery from meningitis are reported, usually without unequivocal¹ bacteriologic evidence, and experimenters and clinicians have favored various programs of heroic drainage and chemical antisepsis, none of which has become an accepted method of procedure. If the practice of autospinal fluid injection and the intraspinal injection of colloidal gold prove efficacious in this disease we have a readily applicable method of treatment. Lauzer¹ reports thirteen cases of epidemic meningitis treated by the intramuscular injection of autogenous spinal fluid with recovery of all but one patient. Rooks² reports two additional recoveries. Sprowl³ reports that Ruttin is using the intraspinal injection of colloidal gold and has had three recoveries, two with positive culture. Because the accumulation of isolated cases in the literature will eventually help to shed some light on this vital question, I am reporting the following recovery of a patient treated by both methods simultaneously.

Miss S. N., a well developed girl of thirteen, had been seen at various times during the two years prior to the present history. She had had asthma when younger, and during the time we had known her had been complaining of definitely allergic nasal symptoms. The septum was markedly deflected, the antra and the frontal sinuses were negative, and the entire middle fossa on both sides was filled with tissue which had undergone polypoid degeneration as had also the middle turbinates. Notwithstanding our respect for this region, especially in one so young, a radical intranasal exenteration of ethmoids and sphenoids was advised. The child was large for her age, dull mentally and very nervous.

*Read before the monthly meeting of the Spokane Academy of Ophthalmology and Otolaryngology, February 24, 1931.

but physical and laboratory examinations, including red and white blood counts and basal metabolism rating, revealed nothing except a relative eosinophilia of 7 per cent, which fitted into the allergic picture. It had, of course, been carefully explained to the family that after the diseased tissue had been removed from the nose the protein sensitivity would have to be controlled before symptoms would be entirely relieved.

Accordingly, under general anesthesia, with postnasal plugs in situ, a partial submucous resection of the septum was done, sufficient to permit further entrance into the nose; and an exenteration of both ethmoids and sphenoids was performed. The sphenoids were not opened until the normal ostia were located and the sinuses sounded. The region was found markedly diseased throughout, but the orbital plates were intact and no operative accident responsible for the subsequent course was recognized. Postnasal plugs were removed as soon as the patient had recovered from the anesthetic, and the nasal packing was taken out in twenty-four hours with little hemorrhage.

On the evening of the second day after operation the temperature, which had been usual up to that time, rose sharply to 104.6 axillary. The patient was rational but drowsy, and there was slight stiffness of the neck. No other symptoms suggestive of involvement of the central nervous system could be elicited. The spinal fluid was under a pressure of 28 mm. Hg., and there were 4,540 cells per cmm., polymorphonuclears predominating. About 30 cc. were removed, of which 20 cc. were injected into the buttock. One ampoule of 0.01 per cent suspension of colloidal gold was injected into the spinal canal. The culture of this specimen and of that taken the following morning showed a nonhemolytic streptococcus, establishing the diagnosis of purulent meningitis. The syphilitic tests were negative.

It was impossible, of course, to follow the classical procedure of surgical removal of the offending focus, as an attempt at such a procedure had produced the condition. As these cases secondary to ethmoidectomy had in the past invariably ended fatally, we decided to push the autoserum and intraspinal gold treatments to the limit, and commenced with the first diagnostic puncture. During the following four days a spinal tap was done every twelve hours, the amount of fluid withdrawn depending upon the

pressure, and all but an amount sufficient for laboratory purposes was injected deep into the gluteal muscles. This differs from the technic of Lauzer, who reduced the pressure by puncture only to 15 or 20, and injected 10 cc. intramuscularly. Rooks also reports injections of 10 cc. Neither of these men combined colloidal gold with the treatment. At each puncture one ampoule of gold was injected into the spine before withdrawal of the needle. For three days the temperature remained between 104.5 and 106.5 rectal, without loss of consciousness, although there was marked apathy. There was never any change in the clinical examinations. On the fourth day the temperature was down to 102 rectal, and the spinal fluid pressure down to 10, with a cell count of 36. Accordingly, the puncture on that evening was omitted. But on the following day the temperature rose sharply to 105. The puncture and treatment were repeated daily thereafter for seven days. There were daily fluctuations of temperature, none reaching 103 rectal. The rises all occurred in the afternoon, declining by midnight. As the treatments were given in the morning it was thought that the gold injections might produce the reaction. The last spinal puncture was done on the twelfth day of the meningitis and no gold was injected. There was no rise of temperature following this, but the result may have been coincidental.

Local and general convalescence was uneventful from then on, and the girl is now perfectly well.

The identification of the organism in this case was not carried to the subdivisions of the nonhemolytic streptococcus. Kopetzky⁴ and Hadjopolos⁵ describe variations in the clinical types of ear infection, depending upon the subspecies of the invading organism. An excellent description of the subgroups of streptococci is given by Bassler.⁶ I wish to suggest that by thoroughly identifying the invading organisms in the cases of meningitis treated by the above methods, we may arrive at valuable information as to the prognosis and efficacy of treatment in any given infection.

DETAILS OF THE TECHNICAL PROCEDURE.

1. Spinal puncture.
2. Withdrawal of 3 cc. of fluid for culture and cell count.

3. Pressure with manometer.
4. Withdrawal of fluid with 30 cc. syringe or allowing it to drip into the syringe until the flow becomes about normal.
5. A 2 cc. syringe containing 1 cc. (one ampoule) of 0.01 per cent suspension of colloidal gold was fitted onto the needle. Fluid was withdrawn two or three times into the syringe to mix with the gold and then the mixture was forced into the spinal canal.
6. Withdrawal of the spinal needle with syringe attached.
7. Injection of spinal fluid into the buttock with large syringe.

CONCLUSIONS.

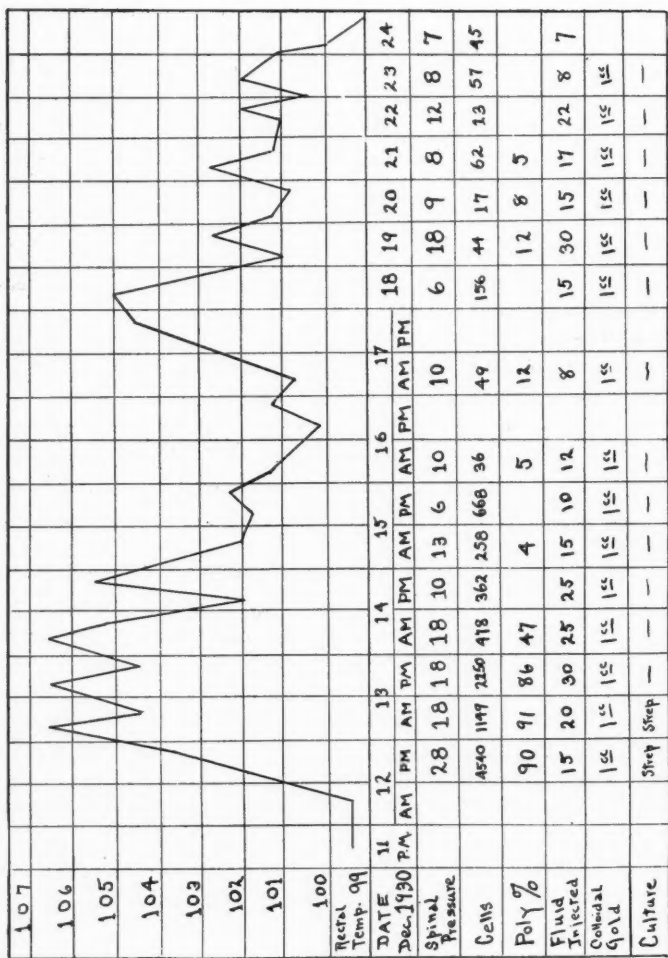
1. A unique case proves nothing, but we hope other observers may obtain similar results.
2. The spinal fluid pressure, the spinal cell count and the proportion of polymorphonuclear leucocytes varied directly with the temperature.
3. The only evidence of unfavorable reaction to the treatment was the possible slight febrile reaction following the puncture and injection.
4. Any treatment which has proved efficacious in a classically hopeless situation deserves trial.*

1569 PAULSEN MEDICAL AND DENTAL BUILDING.

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*Since the above article was written we have been advised by Dr. V. L. Backman of Pasco, Washington, that on the 20th of May of this year the patient was found unconscious and died within forty-eight hours. The clinical diagnosis was meningitis which was confirmed by a high leukocyte count in the spinal fluid. More extensive data have not been received.
—C. A. V., Jr.



LIII.

NONFUNCTIONAL ADDUCTOR PARALYSIS, WITH REPORT OF TWO CASES.*

MANFORD R. WALTZ, M. D.,

SEATTLE.

An exhaustive review of the literature reveals very little concerning pure adductor paralysis, though a great deal has been written on the combined abductor and adductor paralysis (total recurrent paralysis), which may be due to the acute infections, such as diphtheria, typhoid fever, puerperal sepsis, rheumatism and gonorrhea, as well as the more common causes—syphilis, tuberculosis, tracheobronchial adenitis, mediastinal lesions and tumors. Jackson and Coates¹ state that the condition is a rare one if it occurs alone, and that its etiology is injury, enlarged glands, malignant growths, hysteria, diphtheria, neurasthenia, laryngitis, voice strain, general debility, syphilis, lead poisoning, smallpox, enteric and typhoid fever. Stupka² describes several cases of the combined paralysis following acute colds, and states that recovery usually ensues in from three to eight months. Peabody³ reports a paralysis of the vocal cords which showed a perceptible improvement following tonsillectomy. Woldapfel,⁴ of the Hajek Clinic in Vienna, has treated one case of this type of paralysis. Grabower⁵ calls attention to the fact that diagnosis of laryngeal paralysis or paralysis of the recurrent or adductors is often made without laryngoscopic examination and states that great care must be taken to determine the muscles actually paralyzed.

Semon⁶ has formulated the following law which goes by his name: "When in consequence of a general disease the paralysis spreads from one set of muscles to the other, it is the rule that the posticus becomes first affected and afterward the adductors. If both sets of muscles have become affected

*Presented as candidate's thesis to the American Laryngological, Rhinological and Otological Society, June, 1931.

and recovery ensues, the order is reversed and the adductors recover first and later the posticus is restored to power." The question is then raised, and has never been explained, why when two muscles are supplied by the same nerve, one should be paralyzed and the other not.

Paralysis of the laryngeal muscles may be of peripheral or central origin, but the cerebral cortex seldom gives rise to the paralysis. The portion of the central nervous system to which laryngeal paralysis must be referred is the medulla, and especially the region in which the vagus originates. Kenyon⁷ does not believe that the investigations of Semon are conclusive proof of the existence of a cortical representation exclusively for the intrinsic muscles.

Neumayer,⁸ Stupka,⁹ Klestadt¹⁰ and Spiers¹¹ give a review of the various theories and unsolved problems of laryngeal paralysis, and they urge the necessity of collecting proper clinical and experimental data to serve as a basis for collective investigations. They point out that ideas as to the functions of laryngeal muscles may vary, and that it is not strange that the question of innervation is still unclear. Bearing on this statement, Learmonth¹² states that the intrinsic laryngeal muscles, with the exception of one pair, the cricothyroids, are supplied by the recurrent laryngeal branch of the vagus. The motor fibers of this nerve are derived from the internal or accessory division of the spinal accessory nerve; their deep origin is in the *medulla oblongata*, separate from but in close relationship with that of the remaining efferent and afferent vagal fibers.

Case 1.—Mr. L., age 30, married, no children, was working for the Associated Oil Company in December, 1926, when he developed an acute cold and sore throat, which resulted in extreme hoarseness. He recovered from the cold but the hoarseness persisted. I found him to be a well developed man, complaining only of hoarseness and inability to talk above a whisper. Examination showed the nasal mucous membrane subacutely inflamed; septum irregular; sinuses clear on transillumination; the tonsils were large and fluid pus could be expressed from each; the pharynx was subacutely inflamed, also the larynx; vocal cords were thick and pink in color and on inspiration they were abducted normally, but on attempted phonation the right cord did not leave the cadaveric position, while the whole larynx was pulled up and to the left, as shown by the movements of the epiglottis. The blood Wassermann was negative. Examination of the chest revealed nothing abnormal. On February 25, 1926, tonsils were

removed under a local anesthetic. On March 5th, it was noted that the voice seemed slightly better. On March 18th, there was considerable adduction of the right cord. On April 2nd, the right cord moved normally. On May 4th, both sides of the larynx moved normally and together without any rotation of the right side to the left.

Case 2.—Mr. W. W., a banker, age 44, married, no children, consulted me with the following history: About ten weeks ago he drove 150 miles in an automobile. On account of the hot day, he unbuttoned his collar and shirt and let the wind blow freely on his left side. On reaching his destination he found himself unable to speak above a whisper and his throat was very sore. Ten days later he consulted a physician, who had a blood Wassermann made. This being negative, he was sent to a laryngologist, who diagnosed the condition paralysis of a vocal cord, but recommended no treatment. The patient gave a history of having splendid health all his life. Examination showed a well developed, robust man. The nose and sinuses were negative; the tonsils chronically inflamed; fluid pus could be expressed from each; the pharynx was negative; the larynx, atrium and vocal cords were slightly inflamed. On inspiration both cords were abducted, but on attempting to phonate, the left cord did not leave the cadaveric position, while the right one came over to the midline. No other movement could be seen, either of rotation of the larynx or of raising or lowering of the cords. A tonsillectomy was performed on November 4, 1927, and within two weeks the patient was able to speak as well as ever and the movement of the cord was normal. The patient had a small hemorrhage some months later from an esophageal varix.

Two problems here confront us: First, what muscle or muscles are paralyzed? Second, what produces the paralysis?

Cunningham¹³ divides the intrinsic muscles into abductors and sphincters or adductors. Among the abductors may be considered the *crico-arytenoidei laterales* and in part the *thyroarytenoidei*. The adductors are the *cricothyroides* and the *arytenoideus* muscles. Those that have most to do in the production of an adductor paralysis are the cricothyroid and the thyroarytenoid internus, though others enter into the full accomplishment of phonation either as adductors or abductors. A brief description of these is here given. The cricothyroid muscle is placed on the cricoid cartilage and bridges over the cricothyroid interval. Taking origin from the lower border and outer surface of the anterior arch of the cricoid cartilage, its fibers spread out in an upward and backward direction and are inserted into the inner surface and lower margin of the thyroid cartilage and also into the anterior aspect of its inferior cornu. Tension of the true vocal cords is produced by the contraction of the two cricothyroid muscles. The anterior oblique portions of the muscle pull the lower

border of the thyroid cartilage downward, while the posterior horizontal portion, through their insertion into the inferior cornu, draw the thyroid cartilage forward, thereby increasing the distance between the angle of the thyroid cartilage and the vocal processes of the arytenoids. When the cricothyroids cease to contract, the relaxation of the end is brought about by the elasticity of the ligaments.

The thyroarytenoideus internus is a slender, three-sided muscle band which is applied to the outer aspect of the true cord and receives its prismatic form from this adaptation. It arises in front from the angular depression between the two *alæ* of the thyroid cartilage and is inserted behind into the outer aspect of the *processus vocalis* and into the adjoining depressed part of the antero-external surface of the arytenoid cartilage. The thyroarytenoideus internus is slightly thicker behind than in front. This is due to the fact that, while all of the fibers which compose it are attached to the arytenoid cartilage, only a certain proportion obtain attachment in front to the thyroid cartilage, a large number of the deeper fibers are directly fixed at different points to the outer side of the true vocal cord and constitute the aryvocalis muscle. The thyro-arytenoids must be considered as antagonistic to the cricothyroid muscle. When they contract, they approximate the angle of the thyroid cartilage and still further contract the true vocal cords; and when they cease to act, the elasticity of the ligaments of the larynx restores the state of equilibrium. The aryvocales, by the insertion of their fibers into the true vocal cord, may tighten portions of these cords, while at the same time they relax the parts behind. Negus¹⁴ states that when the internal fibers of the thyro-arytenoids contract, they pull on the vocal process if the arytenoid be braced back, and through this contraction tend to make the margins of the glottis rigid. As the degree of the contraction increases, so will the rigidity increase and with it the elasticity of the vocal cords. The external division merely adds support to the internal division if the arytenoid is braced back. Rigidity and elasticity of the vocal cords is therefore produced by the opposing action of the thyro-arytenoids acting on an arytenoid fixed by the cricothyroid, the crico-arytenoidei postici and by the action of the various external

muscles in action with the esophagus. We can say then that paralysis of two muscles will give us an adductor paralysis. First, the cricothyroid, and second, the internal division of the thyro-arytenoid.

Considering the cases under discussion, Case No. 1 shows a right sided paralysis in attempted phonation, with the cord occupying the cadaveric position and the larynx being pulled up and to the left by action of the lateral division of the thyro-arytenoid internus, the other abductors, the external muscles of the larynx, in connection with the action of the esophagus. Negus states that if one cricothyroid is paralyzed, that side of the posterior inferior region of the cricoid ring will lie nearer to the anterior angle of the thyroid and will tend to drop from under the crest of the ala of the thyroid. We have, therefore, a right-sided cricothyroid paralysis.

Case No. 2 may be the same, but there is absent any apparent attempt at movement of the larynx or raising or lowering of the paralyzed vocal cord on attempted phonation. There apparently was only a flaccid cord in the cadaveric position. If we rule out a cricothyroid paralysis, only one possibility remains, and that is a paralysis of the thyro-arytenoid internus, which is supplied by the recurrent laryngeal nerve. If this is the case, then the law of Semon does not hold, for it should be combined with a paralysis of the abductors, and the adductors should be the first to recover.

The second question is problematical, and yet the same conditions were present in both cases—a paralysis brought on by an acute cold and sore throat. This was the only factor that seemed to exist, as hysteria, pulmonary disease and syphilis were ruled out. In both cases the existing tonsils were diseased and were removed. The wisdom of this procedure was shown by immediate improvement in the paralysis and eventually a complete recovery. Unfortunately, a culture was not made from the tonsils of either patient.

We feel, however, that a toxic neuritis was suddenly brought about in each case by the sudden exacerbation of a focus of infection by an acute cold and sore throat, very much as Bell's

palsy is frequently started by a continued draft of wind on the face for some hours, when there are foci of infection about the root of one or more teeth.

SUMMARY.

1. Very few case reports appear in the literature.
2. The first case here reported had a typical true adductor paralysis. There may be some question about the second.
3. Both patients had foci of infection in the tonsils which were aggravated by a cold and sore throat.
4. Both patients had hemorrhages—one from a varix of the esophagus, the other from a duodenal ulcer (neither fatal).
5. Semm's law is not infallible.
6. Recovery quickly follows the removal of foci.

MEDICAL AND DENTAL BUILDING.

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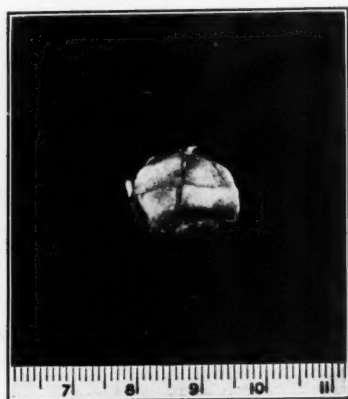
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ANGIOMA OF THE NASAL SEPTUM: CASE REPORT.

VIRGINIUS DABNEY, M. D.,

WASHINGTON, D. C.

Complaining of asthma and nasal obstruction on the right side, both of several years' duration, this patient sought relief from the distress in breathing and occasional bleeding from the nose. Later investigation and study showed the difficulty in breathing to be due partly to the growth in the nose and partly to the asthma, which was exaggerated when the growth seemed to increase in size and exert pressure within the naris. There was seen to project into the lumen of the nasal vestibule, from its attachment to the septum, just posterior to the nasolabial margin, a large cauliflower growth, closely adherent to the septum and the nasal floor. It fitted so snugly into a large perforation it had caused by pressure that inspection of the left naris failed to show this defect. In fact, I did not observe it till after removal of the angioma. However, despite the history of hemorrhage and my manipulation during examination, no blood was seen at this time, perhaps due to the fact that its surface bore numerous plaques of scar tissue, the result of several cauterizations at the hands of another attendant. Strange to relate, the shrinkage to be expected from this treatment did not occur—quite the reverse, in fact, as the growth seemed to be stimulated by it, according to the statement of the patient. These facts, together with the age of the patient (fifty) combined to suggest malignancy, which, happily, did not prove to be the case. With a Luc forceps the growth was removed in its entirety and the only hemorrhage that occurred was due to a small spurting artery, arising at the margin of the septal perforation, which was easily controlled by a crushing forceps. The relentless pressure of this tumor, existing for several years, had resulted in a necrosis of the septum at the site of its attachment. Neither syphilis nor tuberculosis had any part



in its causation. Sixteen months later a small pea-like body of fibrous tissue was snared from the lower margin of the perforation and constitutes the only possible recurrence that occurred during the past four years. It was not angiomatous tissue, however.

The interesting features in this case are that the asthma almost completely disappeared after the removal of the growth and has never been more than slightly troublesome since, whereas it was making the patient's life burdensome and causing all that asthma can do to the sufferer in the way of physical suffering and interference with all his activities. Again, this tumor must have existed as long as two years, according to the statement of the patient, and yet he seemed to find it troublesome only for the preceding six months. The failure to return is the third respect in which it was somewhat unusual, as recurrence is the most striking characteristic of angiomatous growths. It may have been merely a coincidence, but I think that a careful and thorough cauterization with trichloroacetic acid along the entire denuded surface of the pedicle may have prevented recurrence. This treatment I carried out three times at intervals of a week after removal. The report of the pathologist follows: Sections of tissue show innumerable blood vessels of varying size. The tissue is very cellular and many

of the new vessels tend to occur in groups. The tumor mass is entirely subcutaneous and the epithelial covering is normal in appearance. There are some areas of moderate inflammatory reaction. Diagnosis: Angioma, not malignant, but likely to recur.

1633 CONNECTICUT AVENUE.

ERRATUM.

In the summary of the article "Pulmonary Complications Associated with Thrombosis of the Sigmoid Sinus," by Dr. H. I. Lillie, published on page 30 of the March issue, there appeared the following error: "42 per cent" in parenthesis, seventh line from the bottom of page 33 should read (.42 per cent).



R. C. Lynch

ROBERT CLYDE LYNCH.

Robert C. Lynch was born in Carson City, Nevada, September 8, 1880. He was the son of Dr. William Lynch and Minerva Maitlen Lynch. Although a Nevadan by birth, he moved in early childhood to New Orleans, with which city he has been inseparably identified. He received both his preliminary and medical education there, graduating from Tulane University Medical School in 1903. He occupied himself with general medicine for less than two years and then began the study of otolaryngology in Tulane. After a year there he continued his studies abroad.

On his return Dr. Lynch was associated with Dr. A. W. DeRoaldes, a man of unusual breadth of vision, whom he succeeded as Surgeon in Charge of the New Orleans Eye, Ear, Nose and Throat Hospital. It may safely be said that he was the outstanding otolaryngologist of the South and at his death was Professor of Otolaryngology in the Post-Graduate School of Medicine at Tulane University and Consultant in Otolaryngology in the Touro Infirmary. He was a fellow of the American Laryngological Association, the American Laryngological, Rhinological and Otological Society, the American Academy of Ophthalmology and Otolaryngology, the American College of Surgeons and a past president of the American Bronchoscopic Society. He served from its inception as a member of the American Board of Otolaryngology.

He was an indefatigable worker and was known especially for his successful development of the suspension method of laryngoscopy. In 1924 he described in detail a technic for an external radical pansinusitis operation for which he claimed no originality but which he described so meticulously that it is often called by his name. He had a special interest in photography and was one of the first to accomplish cinematography of the larynx. He was pre-eminently a teacher and it was during a visit to a neighboring laryngological society which he was to address that he met his death, a tragedy not only for his immediate family, but for American laryngology.

The ANNALS deeply mourns the loss of this beloved member of its Board; he served it faithfully for many years. He is

survived by his widow, Amanda Genin Lynch, and by two sons, Mercer Genin Lynch and Robert Clyde Lynch, Jr.

THE PUBLICATIONS OF ROBERT C. LYNCH.

Technique of Suspension Laryngoscopy. Read before Section of Laryngology and Rhinology, New York Academy of Medicine, May 25, 1915. *The Laryngoscope*, Dec., 1915.

Suspension Laryngoscopy and Its Accomplishments. Candidate's Thesis to the American Laryngological Society. *ANNALS OF OTOTOLOGY, RHINOLOGY AND LARYNGOLOGY*, Sept., 1915.

Resumé of My Year's Work with Suspension Laryngoscopy. Read before the American Laryngological Association, Washington, D. C., May 10, 1916. *The Laryngoscope*, Dec., 1916.

The Possibilities and Limitations of Suspension Laryngoscopy. Read before Section, Laryngology, Otology and Rhinology at 67th Annual Session of A. M. A., Detroit, June, 1916. *Journal of American Medical Association*, Jan. 27, 1917.

Suspension in Bronchoscopy and Esophagoscopy. Read before Clinical Congress of Surgeons of North America in Philadelphia, Oct. 25, 1916. *Surgery, Gynecology and Obstetrics*, Aug., 1917.

Some Bronchoscopic and Esophagoscopic Foreign Bodies I Have Known. Read before the Section of Ophthalmology, Otology, Rhinology and Laryngology at State Medical Association of Texas, San Antonio. *Texas State Journal of Medicine*, Dec., 1918.

Suspension as I Use It Today. Read at American Laryngological Association, May, 1918. *The Southern Medical Journal*, Jan., 1919.

Fluoroscope Bronchoscopy, Esophagoscopy and Gastrosocopy. Read before American Laryngological Association in Boston, May 28, 1920. *The Laryngoscope*, Nov., 1920.

Fluoroscopic Bronchoscopy, Esophagoscopy and Gastrosocopy. Read at Third Annual Meeting of Association of American Peroral Endoscopists at Boston, June, 1920. *New York Medical Jour.*, March 16, 1921.

The Technique of Radical Frontal Sinus Operation Which Has Given Me the Best Results. Read before the Twenty-sixth Annual Meeting of the American Laryngological, Rhinological and Otological Society at Boston, June 2, 1920. *The Laryngoscope*, Jan., 1921.

Suspension Laryngoscopy and Its Problems. Written for the occasion of the twenty-fifth birthday of *The Laryngoscope*. *The Laryngoscope*, July, 1921.

Technique of a Pansinus Operation. Read in Section, Eye, Ear, Nose and Throat of Southern Medical Association, Seventeenth Annual Meeting at Washington, D. C., Nov. 12-15, 1923. *Southern Medical Jour.*, April, 1924.

Why We Should Demand Poison Labels on Concentrated Lye and Washing Powder Packages. *Jour. of Florida Medical Association*, Nov., 1923.

Diagnosis of Strictures of the Esophagus. Read before the Louisiana State Medical Society on April 24-26, 1923. *New Orleans Medical and Surgical Jour.*, Dec., 1923.

Technique of a Pansinus Operation which Has Given Me the Best Results. Transactions Amer. Lar., Rhin. and Otol. Soc., 205, 1924.

Pot-Pourri, President's Address, American Bronchoscopic Society, St. Louis, May 28, 1924. The Laryngoscope, Oct., 1924.

Some Otolaryngological Problems, Chairman's Address, Section of Eye, Ear, Nose and Throat, Southern Medical Association, Twentieth Annual Meeting, Atlanta, Ga., Nov., 15-18, 1926. Southern Medical Jour., Dec., 1926.

Cancer of the Larynx. Transactions of the Indiana Academy of Ophthalmology and Otolaryngology, Jan., 1926.

Stenosis of the Larynx. Transactions of the American Academy of Ophthalmology and Otolaryngology, Jan., 1928.

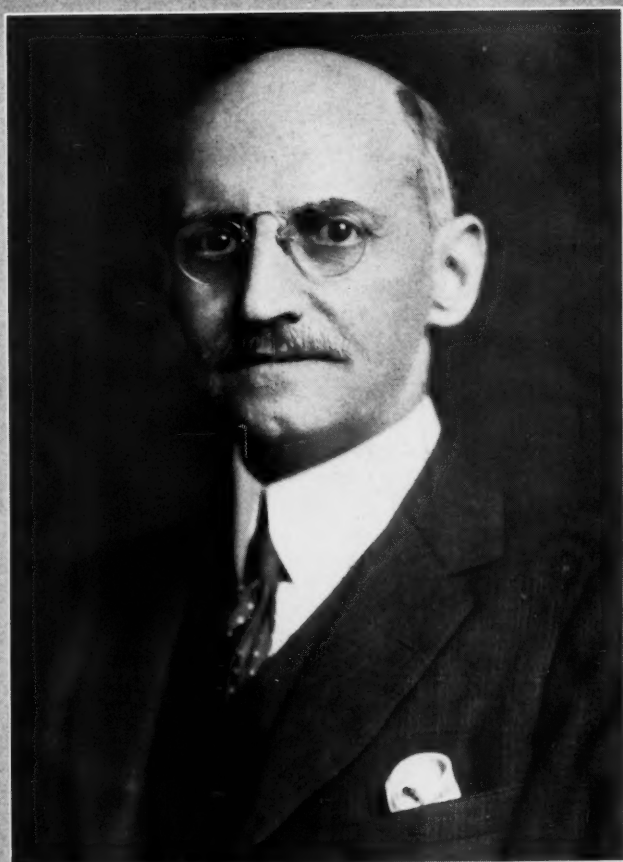
Mixed Tumor of the Parotid Type, Growing from the Posterior Aspect of the Thyroid Cartilage. Read at the Twelfth Annual Meeting of American Bronchoscopic Society, San Francisco, July 6, 1929. Archives of Otolaryngology, May, 1930.

Endothelioma of the Larynx. Read before the American Laryngological Association. Transactions of the American Laryngological Association, 1929.

Sinus Disease in Infants and Children. Read before the Louisiana State Medical Society, April 9-11, 1929. New Orleans Medical and Surgical Jour., Dec., 1929.

Symposium on Ethmoidal Sinusitis, External Radical Approach. Read before the American Academy of Ophthalmology and Otolaryngology. Transactions of the American Academy of Ophthalmology and Otolaryngology, 1929.

Sinus Diseases in Children. Read before Section, Eye, Ear, Nose and Throat at the Sixty-third Annual Session, Mississippi State Medical Association, Vicksburg, Miss., May 14, 1930. New Orleans Medical and Surgical Jour., Sept., 1930.



A. Shuckey

JOSEPH ADDISON STUCKY.

Joseph Addison Stucky was born in Louisville, September 6, 1857, of a family of early Kentucky settlers. His primary education was received in the public schools of Louisville. In 1878 he obtained the degree of Doctor of Medicine from the University of Louisville. For the first decade following his graduation he followed the practice of general medicine, and at the end of that time confined himself exclusively to ophthalmology and otolaryngology. The greater part of his mature life was spent in Lexington, Kentucky.

On May 12th, while driving with Doctor R. C. Lynch of New Orleans, on the Dixie highway, near Lexington, their car collided with a motor bus and both were practically instantly killed. The accident occurred as they were returning to Lexington after a visit to Berea College.

Doctor Stucky was a man of exceptional strength of character, which asserted itself on many occasions during his long and colorful career. He was best known, perhaps, for the establishment of clinics in the Kentucky mountains for the study and treatment of trachoma. From small beginnings, thirty years ago, these clinics have increased in number and size. He was instrumental in the location, at Richmond, of a government hospital for the treatment of trachoma. During the World War he served as consultant in the Medical Reserve Corps.

He was an active member of numerous national medical societies, at whose hands he received many honors. Doctor Stucky was a former president of the American Academy of Ophthalmology and Otolaryngology, and the American Laryngological, Rhinological and Otological Society. He was a fellow of the American College of Surgeons and a member of the Lexington Medical Society, the Fayette County Medical Society, the Kentucky State Medical Society, the Mississippi Valley Medical Society, the Southern Medical Association and the American Medical Association.

Dr. Stucky was the author of many articles which have been published in medical journals and a lecturer on public health and social welfare subjects. He was also a delegate to the International College of Surgeons in London in 1912. For many years and until his death, Doctor Stucky was a member of the Editorial Board of this journal.

PROFESSOR H. ZWAARDEMAKER.

Professor Dr. H. Zwaardemaker, one of the most distinguished of Dutch scientists and the first president of the Collegium Oto-Rhino-Laryngologicum Amicitiae Sacrum, died September 19, 1930. A pupil of Schwartze and Politzer, and later of Donders in Utrecht, he was the earliest authority on the sense of smell, and developed the idea of presbyacousia as analogous to presbyopia. His monograph, *Physiologie des Geruches* (1895), was long the standard work on olfaction. Founder of the Dutch oto-rhino-laryngologic association, and long professor of physiology in Utrecht, he was the first proponent of the sound-proof room for hearing tests, of the choice of test words according to their vibratory speed, and of numerous other physical and physiologic researches. Latterly he was busied with the task of selective audiometry for the purpose of overcoming individual hearing defects with the aid of audion tubes: true "spectacles for hearing." His passing is a conspicuous loss to scientific medicine, and he is mourned by numerous distinguished pupils. F.

NOTES.

The ANNALS has the honor to announce the appointment of three new members to its Editorial Board: Dr. Burt Shurly, Detroit; Dr. Edmund Fowler, New York; Dr. George Tobey, Boston. These distinguished laryngologists should contribute signally in maintaining the high standards of this publication.

The DeRoaldes prize for 1931 has been awarded by the American Laryngological Association to Dr. D. Bryson Delavan of New York. This prize, a gold medal, is awarded every three years by a committee of the Association, for distinguished work in laryngology. It is not given for any special piece of work or thesis, but in recognition of consistent and continued contributions to the specialty. The fund for this prize was established some years ago by Dr. Arthur W. DeRoaldes of New Orleans.

The Casselberry prize of \$500.00 was awarded by the American Laryngological Association, at its recent meeting, to Dr. Arthur W. Proetz of St. Louis, for a thesis which has since appeared as a book entitled "The Displacement Method of Sinus Diagnosis and Treatment." This prize of \$500.00, or a part of this amount, emanates from the Casselberry fund, for encouraging advancement in the art and science of laryngology and rhinology. It may be awarded as a decoration or to defray the expense of investigation and research in the above mentioned domains.

The following are the new officers of the American Laryngological Association, elected at the recent meeting in Atlantic City:

President—Dr. George E. Shambaugh, Chicago, Ill.

First Vice-President—Dr. Joseph B. Greene, Asheville, N. C.

Second Vice-President—Dr. E. Ross Faulkner, New York, N. Y.

Secretary—Dr. George M. Coates, Philadelphia, Pa.

Treasurer—Dr. George Fetterolf, Philadelphia, Pa.

Librarian—Dr. John F. Barnhill, Indianapolis, Ind.

Members of the Council—Dr. Herbert S. Birkett, Montreal, Canada; Dr. D. Bryson Delavan, New York, N. Y.; Dr. Francis R. Packard, Philadelphia, Pa.; Dr. Henry L. Swain, New Haven, Conn.

The following are the new officers of the American Otolological Society, elected at the recent meeting in Briarcliff, N. Y.:

President—Dr. Lee Wallace Dean, St. Louis, Mo.

Vice-President—Dr. George L. Tobey, Boston, Mass.

Secretary-Treasurer—Dr. Thomas J. Harris, New York, N. Y.

Members of the Council—Dr. Harold Walker, Boston, Mass.; Dr. Arthur Duel, New York, N. Y.; Dr. Francis R. Packard, Philadelphia, Pa.; Dr. Samuel J. Crowe, Baltimore, Md.

The following are the new officers of the American Bronchoscopic Society, elected at the recent meeting in St. Louis:

President—Dr. Louis H. Clerf, Philadelphia, Pa.

Vice-President—Dr. Edwin McGinnis, Chicago, Ill.

Secretary—Dr. Richmond McKinney, Memphis, Tenn.

Treasurer—Dr. Waitman F. Zinn, Baltimore, Md.

Editor—Dr. Ellen J. Patterson, Pittsburgh, Pa.

Members of the Council—Dr. T. E. Carmody, Denver, Colo.; Dr. H. B. Orton, Newark, N. J.; Dr. John Miller, New York, N. Y.; Dr. D. Campbell Smyth, Boston, Mass.

The following are the new officers of the Section of Laryngology, Otolaryngology and Rhinology of the American Medical Association, elected at the recent meeting in Philadelphia:

Chairman—Dr. Gabriel Tucker, Philadelphia, Pa.

Vice-Chairman—Dr. Eugene R. Lewis, Los Angeles, Cal.

Secretary—Dr. John J. Shea, Memphis, Tenn.

Executive Committee—Dr. Wm. V. Mullin, Cleveland, O.; Dr. Thomas E. Carmody, Denver, Colo.; Dr. Gabriel Tucker, Philadelphia, Pa.

The following are the new officers of the American Laryngological, Rinological and Otological Society, elected at the recent meeting in St. Louis:

Honorary President—Dr. Edward B. Dench, New York, N. Y.

President—Dr. Edmund Prince Fowler, New York, N. Y.

Vice-Presidents—

Dr. Lee M. Hurd, New York, N. Y., Eastern Section.

Dr. Calhoun McDougall, Atlanta, Ga., Southern Section.

Dr. Austin A. Hayden, Chicago, Ill., Middle Section.

Dr. Alvin J. Lorie, Kansas City, Mo., Mid-Western Section.

Dr. Harold A. Fletcher, San Francisco, Cal., Western Section.

Treasurer—Dr. Ewing W. Day, Pittsburgh, Pa.

Secretary—Dr. Robert L. Loughran, New York, N. Y.

Editor—Dr. George L. Richards, Fall River, Mass.

Members of the Council—

Class A—Dr. Hill Hastings, Los Angeles, Cal.; Dr. D. C. Jarvis, Barre, Vt.; Dr. J. W. Jervy, Greenville, S. C.

Class B—Dr. William H. Haskin, New York, N. Y.; Dr. Harold I. Lillie, Rochester, Minn.; Dr. W. P. Wherry, Omaha, Neb.

Class C—Dr. Joseph C. Beck, Chicago, Ill.; Dr. Perry B. Goldsmith, Toronto, Canada; Dr. Max A. Goldstein, St. Louis, Mo.

Abstracts of Current Articles.

Bacteriology of Suppurative Otitis Media (Contribution à l'étude bactériologique des suppurations auriculaires a microbes pyogenes aérobies).

J. Bonnahon (Montpellier), Arch Int. Lar., 9:877, Sept.-Oct., 1930.

Working at the Hôpital St. Louis in Paris on Lemaitre's service, Bonnahon has made a detailed study of all aerobic organisms, especially as to prognosis and treatment of mastoiditis. Streptococcus mucosus requires immediate and very extensive operation. Staphylococcus mastoiditis can be sutured up immediately, while streptococcus wounds must be left widely open. Vaccine therapy, except for staphylococcus cases, is not worth much.

Complicated cases nearly all have some type of streptococcus. Pneumococci have a favorable prognosis, except for type III streptococcus (or pneumococcus) mucosus. A few cases of Friedlander's bacillus and pseudodiphtheria organisms were found.

F.

Hardening Injections for Reduction of Hypertrophy of Nasal Mucosa (Les injections sclérosantes, Traitement de choix des hypertrophies de la muqueuse nasale).

Dutheillet de Lamotte, M. D. (Limoges), Rev. de L. O. R., 51:657, Nov 1930.

In the absence of bony deformities, the author makes three to four submucosal injections down to the periosteum of the affected turbinate, after slight cocain anesthesia, using 5 per cent quinin urethane solution. No postoperative inflammations or adhesions have been observed.

F.

The Syndrome of Paleness and Hyperthermia in Childhood: Case Report after Oesophagoscopy. (El Síndrome Palidez e hipertermia en pediatria.)

A. Llerena Benito, Rev. Esp. y Am. Lar., Ot., Rin., 21:481, Dec., 1930.

Fever mounting very high, with extreme paleness, is a syndrome not infrequent after operative procedures on children, more often in the first two months, but occasionally seen up to the fifth

year. Ascribed by some to general anesthesia, by others to thymic dysfunction, others conceive of a violent disturbance to the nerves of general or visceral sensation, with accompanying upset to the vegetative nervous system, not yet adapted by the infant to the automatic regulation of metabolic upsets.

Hyperthermia and peripheral vasoconstriction seem to be bulbar in origin. Previously reported cases range from paracentesis and mastoidectomy to bronchoscopy and the removal of angiomata. The author's case, removal of a coin from the upper esophagus of a three-year-old, eighteen hours after it had become lodged, had had both cocaine locally and light chloroform anesthesia. Removal was slow because of marked spasm; there was no appreciable trauma of the esophageal wall. Fever went up within five hours to 107°. A radiograph taken sixteen hours later was entirely normal; there was no dysphagia or dyspnea, and after twenty-six hours the temperature started down, reaching normal the second day. No sign of mediastinitis was ever present; dehydration had not occurred; and the author concludes that shock because of imperfect general and local anesthesia was the main factor in his case. F.

M. Lapasset, working under Professor Caubet of Toulouse, has contributed a long thesis to the theory of shock and of immature vegetative neural adjustment. (*Syndrome paleur-hyperthermic chez les nourissons opérés.*) Thèse de Toulouse, Feb., 1930. F.

Deafmute Children Should Begin Training Before the Age of Three.
(*Les enfants sourds-muets doivent recevoir les premiers soins médico-pédagogiques avant l'âge de 3 ans.*)

G. de Parrel (Paris).

Instead of waiting until children are seven or eight years old, Parrel (Director of the French Centre of Reeducation) thinks they should be given a chance at about two years, when the impulse toward speech normally becomes active, and he suggests that lip reading, force of example, and association of pictures, toys, miniature household articles with the spoken word; number games, manual exercises and the like as helpful in retaining the interest of these children and in fostering their normal development along with others of their age. F.

Headache Associated with Intracranial Hypertension (La céphalée dans le syndrome d'hypertension intracranienne).

Prof. G. Portmann (Bordeaux), Rev. de L. O. R., 52:1, Jan., 1931.

The author finds headache more constant in the inflammatory intracranial conditions than in the presence of tumors. F.

Removal of Retropharyngeal Tumors. (Asportazione dei tumori retrofaringei.)

Prof. T. Della Vedova (Milan), Boll. Malatt. Orecch. Gola Naso, 49:65, March, 1931.

After preliminary use of coagulen and several days of calcium by mouth, the author locally shrinks and anesthetizes the nose and throat with the patient seated. With the left index finger the operator palpates the tumor through the mouth, guiding the jaws of an ordinary nasal forceps with cupped dull ends—of the Grünwald or Luc type, depending on the capacity of the nasal passages. This forceps is held in the right hand, and care is taken that the tumor is not lacerated or cut, but rather crushed and twisted down from its broad pedicle, a little at a time. This process of "mastication and fracture" requires three or four sittings of ten to fifteen minutes each, usually spaced two days apart. Following each stage, the parts are cleansed and a tampon of hemostatic and anesthetic agents is used in the nasal fossa traversed. At the last session the tumor is found much loosened and may be detached from its bed without the usual hemorrhage and without the necessity of a postnasal tampon. Convalescence is very rapid after this type of removal and complications are very rare. F.

Reeducation of the Singing Voice. (La Rééducation de la Voix Chantée.)

DeParrel and Matha (Paris), Rev. de Lar., Ot., Rhin., 52:41, Jan. 1931.

Starting from the proposition that most faults in singing are due to improper technic, leading to overuse or misuse of the vocal organs, this article discusses and demonstrates, by pictures, all types of functional trouble with the singing voice. Proper diaphragmatic breathing, relaxation of the pharyngeal muscles, and even emission of the inspired air are stressed, with detailed directions for the correction of faulty habits. Projection of tone

into the nasal cavities instead of forward against the anterior part of the hard palate may readily be corrected by muscular relaxation. Instead of the usual "musical slang" which inaccurately depicts the facts of voice production, the use of pictures which show the anatomy of these structures and the collaboration of the laryngologist with the singing teacher are considered most important. Instead of pushing the student into difficult types of solo or repertory singing, he should be taught the mechanics of his art: breathing, muscular control, the use of his resonance chambers, correct articulation. F.

Training of Otolaryngologists; the Title of "Specialist" in Latin Countries.

Assumption of the title of "specialist" has been causing some discussion in France and Italy during the past year, because numerous unqualified individuals have been attempting the practice of otolaryngology with unfortunate results. Recently Italian law has required three years of special university study, inflicting a great hardship on many beginners who lack the means for so extensive a course. So far no government stipends are available for these students.

Bobone of San Remo (Boll. Malatt. Orec. Gol. Nas., 49:42, February, 1931) inclines to the feeling that such purely didactic work is inadequate, and should be supplemented or augmented by practical association with large clinics, where actual operative experience may be gained; and he agrees with Lautmann (Ann. Mal. Oreille Lar. Nez ec. Jan., 1930), that a system of mutual recognition among specialists should be established. No such system exists in Latin countries.

The editor, Orlandi of Florence, quotes with high approval the practical nature and successful application of the system of voluntary examinations, used by the American Board of Otolaryngology, and expresses the hope that some such system may eventually be adopted in order to stem the rising tide of commercialism which threatens the younger group of Italian specialists, recently deprived by death of several of their great leaders and teachers. F.

Society Proceedings.

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY.

Regular Monthly Meeting, Monday, February 2, 1931.

THE PRESIDENT, DR. GEORGE DENNIS, IN THE CHAIR.

Presentation of Pathological Specimen: Carcinoma of Larynx.

E. E. MEISTER, M. D.,

AURORA, ILLINOIS.

A man, aged 57, was first seen on November 19, 1930. He gave a history of hoarseness of five years' duration. In 1925 he was examined elsewhere and nothing was found in the larynx. He went to Arizona, but roentgenograms of the chest and tuberculin test both were negative. The hoarseness persisted for about a year, when it cleared up somewhat, but always became more pronounced toward evening. He spent his winters in Arizona. In the spring of 1930 he noticed a lump below the larynx, which increased to the size of a hen's egg. He had some pain in the throat and some difficulty in swallowing and breathing.

He came to Chicago to consult a goiter specialist and a diagnosis was made of thyroid abscess. This was opened and drained serous pus. He remained in the hospital for about four weeks, but a week later the abscess was again opened and the hoarseness became more pronounced. The difficulty in swallowing increased to the point where he could take no solid food.

When seen by Dr. Meister he was cyanotic and slept sitting up. He had not taken food for two weeks. Examination showed a mass in the midline of the larynx which obscured the vocal cords. The patient was ordered to the hospital, Dr. Lewy was called in consultation and a tracheotomy was performed. He lived for about five weeks, although breathing was very uncomfortable, and he was unable to swallow food.

The Wassermann reaction was repeatedly negative.

PATHOLOGIC REPORT.

DR. ALFRED LEWY: When I first saw this man he had a large suppurating swelling that occupied most of the front of the neck. I made a provisional diagnosis of carcinoma of the larynx and an immediate tracheotomy was performed, as the man was in a critical condition of anoxemia.

The history stated that in April, 1930, an incision had been made in the swelling and the patient was subsequently treated for syphilis by a well known man. The tracheotomy was done under local anesthesia with the patient sitting up, and we had to go through the thyroid to place the tube.

Examination of the specimen showed squamous cell carcinoma.

DISCUSSION.

DR. HARRY L. POLLOCK: It is possible that a carcinoma may have existed that long. About a month ago I operated on a patient who first noticed hoarseness seven years before. It persisted for two years in the beginning, then practically disappeared for a short time but recurred. It was a slow growing carcinoma. We have always tried to point out that hoarseness that improves at times but never disappears, excluding tuberculosis and syphilis, is almost pathognomonic of carcinoma.

Progressive Osteomyelitis of the Cranial Bones Secondary to Suppurative Nasal Sinus Disease.

C. F. YERGER, M. D.

(AUTHOR'S ABSTRACT.)

There are two types of progressive osteomyelitis due to nasal sinus disease: the type which develops spontaneously and the postoperative type. The frontal sinus and the frontal bone are most frequently involved. In the vast majority of cases the causative organism is the staphylococcus. The pathology is characterized by a progressive osteomyelitis of the frontal bone or other cranial bones. The spread may be by continuity of the diseased bone or by involvement of the healthy bone via infective thrombophlebitis of the diploetic veins. Besides the osteomyelitis, two other pathologic conditions are associated, the pericranial,

or subperiosteal abscess, and the extradural abscess. Clinically, the pericranial abscess is readily recognized by the formation of a soft, doughy or puffy swelling over the site of the osteomyelitis. This was first noted by Percival Potts over 170 years ago in cases of osteomyelitis of the cranial bones due to external trauma. The presence or absence of an extradural abscess in these cases is not so easily diagnosed, and this is the great hidden danger of this disease.

In order to establish nasal sinus disease etiology this must be demonstrated as the causative factor. This was first accomplished by Luc and Tilley, in 1899; since then about 100 cases have been reported. The roentgenogram is an important aid in diagnosis and in obtaining a graphic chronologic record of the course of the disease. These cases are prone to have relapses and no case should be considered cured until after an interval of at least one year.

The prognosis is unfavorable. McKenzie noted that the mortality in the postoperative cases was 70 per cent and in the spontaneous cases 30 per cent. The cases with intracranial complications, as meningitis, brain abscess and thrombophlebitis of the dural sinuses are fatal.

The surgical treatment should be based upon wide exposure and a wide open wound, with early drainage of pericranial and extradural abscesses. All loose sequestra should be removed and the wound packed with vaselin gauze. Allow the bone to sequestrate and remove the loose sequestra. Always remember that an intact lamina interna may hide an extradural abscess. Save as much of the internal table as possible, as the bone regenerates from it. Remove the anterior and posterior wall of the frontal sinus but conserve the supraorbital ridge and inferior wall of the frontal sinus.

DISCUSSION.

DR. HARRY L. POLLOCK: I wish to emphasize one or two points. Dr. Yerger stated that in scarlet fever, influenza and so on, there is always a lowered resistance. That is true of all these diseases, and I think it can be expected because the body has not had time to build up an immunity. Later on he said that we carry the patients along until they build up an immunity, but the acute

infections come on so abruptly that there is no time to build up the resistance.

I am a believer in early, radical treatment in these cases. I think the cases are comparatively rare in private practice, but I have seen some of them. I think many of the 100 cases reported were not seen by rhinologists, and I wish to mention two cases which were in the hands of general surgeons when I was called in consultation. The first patient had the typical soft swelling, the puffy tumor, which the surgeon opened and curetted. Soon a similar spot appeared on the opposite side and he used the same treatment. I agree with the essayist regarding too early operation, but I think radical measures must be used occasionally when there is ethmoid, frontal or any other sinus involvement. I believe many of the complications are due to too early operation, before Nature is given a chance to wall off the pathologic process. I advised in this case that an extensive operation be done, going as far beyond the border of the sequestrum as possible to remove the diseased bone. It is far better surgically to take away too much bone than too little, for if we do not carry the removal into healthy bone the disease will continue and progress until the whole cranium is involved.

I wish to present just one slide, which demonstrates (1) the great amount of bone which can be removed from the cranium without any untoward symptoms and without any great amount of deformity, and (2) the amount of regeneration which occurs in the formation of new bone, both from the edges of the old healthy bone and from the outer layer of the dura. This slide is an X-ray of a young woman who has had osteomyelitis of the skull following a mastoid operation. She was under the care of a general surgeon. At least a dozen spots may be seen over both sides where large amounts of the bone were removed at various times extending over a period of years. She finally made a complete recovery—i. e., she has remained free from symptoms now for over a period of two years. The areas that were operated upon early now show new bone formation, and if closely examined one can tell by the amount of new bone formation just where the disease began and its progress can be followed. I saw the patient last summer, and on physical examination of the skull

could scarcely detect any irregularities anywhere, demonstrating that regeneration has occurred over the entire operative terrain.

DR. AUSTIN A. HAYDEN: I only wish to call attention to the fact that in the last number of "The Laryngoscope" there is a report of frontal sinus operated upon with recovery.

DR. EDWIN MCGINNIS: I have had seven or eight cases of osteomyelitis about the frontal bone, at the Presbyterian Hospital, which I have treated surgically with no deaths. There are many hundreds of individuals suffering from sinus infections who do not have osteomyelitis. Many cases have been operated upon externally, and the staphylococcus aureus hemolyticus has been found in the discharge with no osteomyelitis. I think that the important thing in the etiology is that the staphylococcus aureus pyogenes is brought into the wound as a contamination, and this produces the osteomyelitis. When I first read LeMere's report of some cases resulting in death, and then heard Lillie tell the same sad story, and later Ross Skillern, I was very much "down in the dumps." But at the sectional meeting of the American Medical Association at Portland, a couple of years ago, Dr. Samuel Skillern reported a case which he had treated that resulted in a cure. One evening, a good many years ago, I listened to Dr. Phemister talk about osteomyelitis of the long bones, and I learned a lesson in treating these cases. I have made wide exposures through long incisions, removed the sequestra, if any were present, and then packed the wound with iodoform gauze. This packing is left in for a month or six weeks or until all of the advancing infection has stopped. It is with this method that I have been able to get cures in this difficult situation.

DR. JOSEPH C. BECK: I wish to report the case of a child I saw in consultation with Dr. Woodruff in Joliet. It was an acute sinusitis in a young child. They had already operated by making an incision over the infected sinus. The child recovered from the acute condition and I saw it about a year later with an infection in the arm. A general surgeon, to whom I referred the case, made a diagnosis of secondary infection of osteomyelitis of the humerus. At about the same time the boy developed a puffy tumor over the left side of the head. The resistance and general condition of the boy were very good. Two general men saw the case in consulta-

tion, and one was for radical operation of the head and arm, while the other one and I both urged conservative treatment. I mention this on account of the LaPorte treatment, which is some kind of a mixture of potassium nitrate and oatmeal, which we used as a poultice after I made an incision over the head tumor and drained and Dr. A. A. Strauss did the same thing in the arm. Daily dressing and application of the LaPorte mixture was carried out. The boy has recovered full function in the arm, and the swelling of the head has disappeared. The X-ray study of both the head and arm has been most instructive. At one time the clinical picture as well as the X-ray of the skull indicated progress of the disease, and I was seriously thinking of performing the extensive operation, recommended by Dr. Furstenberg of Ann Arbor. However, the process again subsided and now appears to be cured. I have seen several cases of this type, one in which I did an exposure of the frontal sinuses in the belief that it was a bilateral sinusitis. I found it was a late case of osteomyelitis and took off the whole outer table of the frontal bone.

The operation in the early stages does not do so well. Dr. Kemp of Los Angeles showed me a case of acute osteomyelitis in which he had gone through the skin and on to the bone, entirely across the head from ear to ear, by means of the electrocoagulation knife, and the patient recovered. The idea of the electrocoagulation of the infected process was to stop its progress. Dr. Lynch, in his operations on many frontal sinuses, I think, has shown that by great care in lifting off the periosteum from the frontal bone infection in the bone has been prevented. I am sure Dr. Yerger is right in his statement that many wounds, particularly in the bone, become infected at the time of operation.

DR. GEORGE H. MUNDT: I think we might well learn from the work of Dr. Orr, of Lincoln, Neb., and other orthopedists regarding the treatment of these infections. That is, leaving the wound open, packing with vaselin gauze and leaving it there for weeks or months. There is one man here in Chicago who has done more work than Dr. Orr and another in New York who has done considerably more than Dr. Orr, using his method. The idea of putting in iodoform gauze and pulling it out and repacking the wounds from time to time has its disadvantages.

DR. C. F. YERGER (closing): I wish again to stress the point mentioned by Dr. Lambert, viz., that it is important to remove the internal plate of the frontal bone for the purpose of either locating or excluding the presence of an extradural abscess, which is the great danger in these cases of progressive osteomyelitis of the frontal bone.

I was glad to hear of the vast experience and the splendid results obtained in the treatment of progressive osteomyelitis of the frontal and other cranial bones secondary to nasal accessory sinus disease, as related by Dr. McGinnis. His case offers additional proof that these cases should not be sutured and the wound must be left wide open.

In order to avoid the possibility of a secondary osteomyelitis as a complication following a Killian operation on the frontal sinus, we should be careful not to detach any more of the periosteum over the frontal bone than is necessary and to have the bone beveled so that there will be no overhang with an undermining of the posterior bony margin. Also, we should be sure to provide good intranasal drainage by means of a rubber tube.

DR. AUSTIN A. HAYDEN addressed the Society and presented a motion picture on

"External Frontal Sinus Operations."

DISCUSSION.

DR. J. HOLINGER: The motion picture demonstration of Dr. Hayden was certainly very instructive. The first patient with the enormously swollen upper eyelid hanging down over the lower lid came to Dr. Blomgren, an assistant of Dr. Hayden, during Dr. Hayden's absence, and was operated upon by me as an emergency, since it was evident that there was a retrobulbar abscess. The man had experienced several lighter attacks of the same kind before. There was no secretion in the nose, and a probe did not enter the frontal sinus. A roentgenogram showed a large cloudy sinus, the limits blurred. On opening, the periosteum could be freed from the bone with difficulty. Everywhere tough connective tissue was encountered, in which the trochlear muscle also was enveloped (old scars from former inflammations). Working along the roof of the orbit an abscess, containing 30 cc. of pus

under pressure, was opened, about 1.5 cm. from the supra-orbital arch. An opening in the roof of the orbit, 2.5 x 1 cm., led into a large frontal sinus; from this sinus another opening in the depth led into the extradural space. No communication with the nose could be found. We had, therefore, an empyema of a frontal sinus which had no communication with the nose, but a fistula into the orbit and another into the skull cavity, an extradural abscess.

In the Yearbook for Eye, Ear, Nose and Throat, for 1930, is the following:

"In this country there spring up, from time to time, the advocates of radical and external operations. The reason for this seems to be that these men who are advocating operations of this sort have not had the patience to master the difficult intranasal surgery required to carry out a successful operation, and their preparation has been more along the lines of a smattering of general surgery, which they proceed to apply to the external operation and apparently without any definite realization of what the proper indications on the sinus really are."

It is unfortunate but true that the ear, nose and throat men work out special anatomy, special diagnoses, special indications, special technic for their actions in their territory. Ignorant of this work, some surgeons invade this territory. Many of these invasions are certainly not for the best interest and welfare of the patients.

DR. C. F. YERGER: Dr. Hayden's motion picture demonstration and his explicit explanatory legends have been instructive.

The fact that progressive osteomyelitis may follow a Killian radical frontal sinus operation, because this operation frequently requires opening of the diploetic spaces in the frontal bone and also the detachment of the periosteum over the frontal plate, would lead one away from the Killian to the Lynch operation, as a means of lessening the danger of this complication.

DR. EDWIN MCGINNIS: I was very glad, indeed, to see Dr. Hayden's pictures and to find that he used the simple Killian procedure in his work. I have leaned more towards the modified Lothrop operation in attacking the frontal sinus externally, but they are both equally good in attacking the infection.

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL
SOCIETY.

Regular Monthly Meeting, Monday, March 2, 1931.

THE PRESIDENT, DR. GEORGE DENNIS, IN THE CHAIR.

Agranulocytic Angina.

FRANK J. NOVAK, JR., M. D.

(AUTHOR'S ABSTRACT.)

The report was based on the study of seven cases of agranulocytic angina which occurred in the writer's practice. Six of the patients died and one recovered. It was pointed out that owing to the multiplicity of therapeutic agents employed in the one case which recovered, in the desperate effort to save the patient's life, a critical appraisal of any single agent was impossible. However, it was noted that during the period of six weeks of the patient's illness, the time during which a nonspecific protein (Omnadin) was being injected the most definite rise in the number of polymorphonuclear cells occurred. This, however, was not permanent. Following the injections of the protein, X-ray therapy was employed, and it seemed that the permanent improvement in the blood picture took place then.

If the essential pathologic change in this disease is a non-inflammatory liquefaction of the bone marrow of such bones as the sternum and the ends of the ribs, etc., it is difficult to see how stimulating doses of X-ray or the injection of nonspecific protein can stimulate myelopoiesis. One may speculate upon the possibility of an extramedullary myelopoiesis. That such does occur in other conditions, as, for instance, following frequent and severe bleeding of experimental animals, is an accepted fact. On this basis it is possible that in the case of the patient who recovered not all of the marrow concerned in the formation of the granulocytes had undergone necrosis. The stimulating effect of the protein injections plus that of the X-rays forced the remaining available marrow to supply the organism with new granulocytes. Other organs not normally given to the elaboration of polymor-

phonuclear neutrophile cells as, for instance, the walls of large blood vessels, were stimulated to an unusual activity.

Of the seven cases reported two were undiagnosed antemortem. One case had undergone a long series of injections for many months in the treatment of an acute arthritis. What the nature of this treatment had been the writer had been unable to learn. In this case the patient died five days after the onset of the angina. One patient died of hemorrhage from the throat. Three of the cases were male adults. Three cases were female adults, and one was a female, aged 12.

Smear from the ulcers showed a spirillum and a fusiform bacillus in all of the cases.

All cases ran a febrile course to the end, except in the one patient who recovered, and he had a normal temperature after the first week of his illness.

All the cases showed ulceration of the throat. The ulcers were multiple and steadily increased in size, with the exception of the one which recovered. In this case the ulceration disappeared after six weeks.

Until the essential pathology is worked out and the etiology becomes known it is highly improbable that a satisfactory therapy will be developed. In the meantime the clinician is forced by the malignity of the disease to attempt any and all forms of therapy that have been employed.

DISCUSSION.

DR. J. P. SIMONDS: The subject of agranulocytosis is of great interest because cases are appearing with increasing frequency and the death rate is high. From what I have seen of the pathology of this condition it seems that the bone marrow is put out of commission so far as the production of polymorphonuclear leucocytes is concerned. In the cases I have studied there were areas of necrosis which involved all of the cells in the bone marrow indiscriminately in the necrotic foci. In the same cases, however, sometimes forming a ring around the area of necrosis, there was evidence of red blood cell formation, but none of polymorphonuclear leucocytes. What it is that has such specific action on the

cells which produce polymorphonuclear leucocytes in the bone marrow I cannot say. Whatever it is, it seems to be quite specific, and yet this specificness overflows enough to involve all parts of the bone marrow in some parts of the structure. We do not know of any drug, or of any bacterial toxin, or any physical phenomenon which has such a specific action. The effect of benzol is, perhaps, the nearest approach to it.

I think a promising line of investigation would be to try, after some thorough-going thinking along the lines of the possibilities in the case and the nature of the formation of leucocytes, to search out some substance which would have a specific effect upon bone marrow. Ehrlich ran through 606 chemical substances before he found the specific for syphilis. It may be that someone with equal patience and persistence might find the specific chemical causative substance for this condition. Whether it led to the discovery of a specific for the treatment of agranulocytosis or not, it would open a field of research that would be extremely interesting.

The pathologist feels that the underlying pathology of every disease furnishes the only rational basis for treatment. As long as we know only the effects of the angina and do not know the agent that produces it we do not know how to combat it. It seems to me that anything which holds out any possible hope, no matter how empirical it is, is worth trying. Some years ago nucleic acid was used to prevent peritonitis because it was believed to stimulate the production of polymorphonuclear leucocytes. Any substance that will stimulate the formation of bone marrow should be of value, provided there is enough substance left in the bone marrow to be stimulated. I have seen references to the use of serum from patients who have recovered from the disease, and wonder if anyone here has used such a method of treatment. It would seem that it might hold out some possible hope of good results. If we ever find out what the organism is, if it is due to bacterial infection, it may be possible to produce an antibody that would act as a therapeutic agent in this condition.

DR. LAURENCE HINES: There is little left to discuss after Dr. Novak's paper and Dr. Simonds' excellent exposition of the sub-

ject. However, I have had the opportunity of making postmortem examinations and seeing clinically three of these patients in the last few months, and there are a few points I might mention.

One is the frequency of liver degeneration and jaundice. In all three of the patients I saw there was marked jaundice, and the liver showed pronounced necrosis, without any inflammatory reaction. One patient had a positive culture for diphtheria bacilli made from the ulcerated area. This produced a very confusing clinical picture. Diphtheria antitoxin caused no improvement.

Another thing that has impressed me about these cases is the infrequency with which Vincent's spirillæ have been found, in spite of the fact that the disease originally was supposed to be a spirochetal affair. I brought with me specimens from two patients, one larynx, pharynx and trachea, showing typical ulceration; the other case presented no pharyngeal ulceration, but showed typical lesions in the esophagus and colon. Here are two specimens of the colon, one showing widespread areas of necrosis and the other localized necrotic lesions. In the esophagus of this patient there were localized areas of necrosis. She had as the presenting symptom a dysphagia, and this was a striking symptom throughout the illness.

DR. CHARLES B. YOUNGER: I have the distinction of having been associated with a case of agranulocytic angina which recovered. I do not claim that I cured the patient. The case was seen a year and one-half ago and the patient is living and well, so far as we know.

I wish to mention the classification of these cases. I had occasion at that time to look up what little literature there was on the subject and was struck by the lack of uniformity in the reports of these cases. Some were called agranulocytic angina, others agranulocytosis, and only a few agreed with the pictures of the first two cases that were reported in Europe. Some of the patients did not present throat findings and yet there was a great diminution of leukocytes and polymorphonuclears.

The case I was connected with occurred in a man who was then 68 years of age. He had been a vigorous person all through his life, with no history of illness. He became ill with what his

family doctor thought to be a peculiar tonsillitis, of follicular type. I wish to emphasize the finding in his case of something that I believe exists generally in this class of cases, and that is marked prostration. This man went on for four or five days, gradually becoming weaker. Cultures had been made of the throat which showed a great preponderance of staphylococci. There were ulcers around the teeth and an ulcer in the right tonsil which became larger. From these ulcers the typical Vincent's bacillus and spirillum were recovered. We did not succeed in finding the *B. pyocyaneus* in blood examinations. When I first saw the patient our attention had just been called to this disease, and because the condition in his throat and the other findings did not conform to any of the things with which we are familiar in the throat, and because I was interested in this rather new subject, I felt that it might be that disorder. I had the patient taken to one of the hospitals with instructions to have a blood count made. A short time later the technician called me and said there were less than 1,000 leukocytes and no polymorphonuclears. The next morning the blood was typed and the patient was given a transfusion. He received three transfusions within a week, at the end of which time he was getting better. There was a slight increase in the polymorphonuclears following the transfusions and gradual improvement in all ways. The patient was discharged in about two weeks. In addition to the transfusions he was given very large doses of quinine.

DR. GEORGE T. JORDAN: We had an interesting case at Mercy Hospital in a man who recovered. He was a patient of one of the younger men, Dr. Sweeney, who is here and I am sure will be glad to tell us about it.

DR. LEO P. A. SWEENEY: The patient was a priest, aged 34, and I first saw him on a Monday. At that time there were small hemorrhages over and between the left lateral and central incisors and he was sent to the hospital for a white count. On Tuesday he had 950 leukocytes with no polymorphonuclears, nor transitionals; there were 66 per cent lymphocytes. The lesions had spread behind the same teeth on the left side of the mouth. On Wednesday the white count was 1,025, with no polymorphonuclears, nor transitionals. On Tuesday we had given him 0.45

neosalvarsan and an X-ray treatment and this was repeated at this time. On Thursday the white count was 1,350 with no polymorphonuclears, nor transitionals. He was given another X-ray treatment and in addition was given whole blood into the hip and turpentine into the thigh subcutaneously. The mouth and throat were very sore and sometimes it was necessary to give him as much as three-fourths grain of morphine at a dose. On Friday the white count was 1,100, with 2 per cent polymorphonuclears, no transitionals. He was given another X-ray treatment and another injection of leukocytic extract. On Saturday the white count had increased to 1,150, with 4 per cent polymorphonuclears and 16 per cent transitionals. The hip was sore. The lymphocyte count was 80 per cent; the day before it was 92 per cent. He again received X-ray therapy, and some blood into the thigh. On Sunday he had 1,300 white cells with 3 per cent polymorphonuclears and 34 per cent transitionals. He was given another injection of leukocytic extract; his thigh was very sore.

On Monday there were 4,500 white cells with 46 per cent polymorphonuclears; there were 46 per cent lymphocytes; more leukocytic extract was given; thigh extremely sore, red and swollen.

Tuesday there were 6,700 white cells with 35 per cent polymorphonuclears; 35 per cent transitionals; lymphocytes down to 23 per cent; temperature 99.6° F.

Wednesday there were 7,950 white cells with 50 per cent polymorphonuclears, 12 per cent lymphocytes and 33 per cent transitionals. The lymphocytes continued between 20 to 30 per cent. There was evidence of a true abscess in the thigh and it was very sore. The mucous membrane was hanging down in his mouth, and we clipped that off in several places so that it would not trouble him. The temperature was normal and remained normal. The pulse went under 100 and a week later under 90.

Thursday the white count was 8,050 with 54 per cent polymorphonuclears. Friday the white count was 8,100 with 55 per cent polymorphonuclears.

On the following Tuesday, the fourteenth day, there were 7,750 white cells with 62 per cent polymorphonuclears. On Friday, the seventeenth day, the white cells were 7,050 with 67 per

cent polymorphonuclears. On Wednesday, the twenty-second day, there was 7,200 white cells with 63 per cent polymorphonuclears.

Four weeks after the diagnosis was made he had 7,150 white cells with 58 per cent polymorphonuclears. At five weeks he had 6,900 white cells with 59 per cent polymorphonuclears. At six weeks there were 9,400 white cells with 69 per cent polymorphonuclears.

The temperature ranged between 101 and 103.4 degrees F. until about thirty hours after the white count began to increase. The pulse was high at all times, 120 to 124.

The man apparently is in good condition at present. The two incisors over which the lesions first appeared dropped out while he was still in the hospital, and he has since had the two molars on that same side extracted. It is now eight weeks since the onset.

DR. FRANCIS L. LEDERER: In the last ten years I have seen fourteen cases of this disease. It is very evident, from the reports in the literature and the discussion tonight, that the treatment is hit-or-miss. There is nothing about the therapy that we can attach any importance to, and so we are of the opinion that the patients get well despite the treatment. In our series we have had two recoveries. The jaundice, as Dr. Hines mentioned, gives a very poor prognosis. We are of the opinion that the angina is not a part of the agranulocytosis but is a manifestation of the severe toxemia. We have seen two cases recently that ended fatally. We were able to observe the lesions early, and it seems they are hemorrhagic at first, with marked demarcation of the hemorrhagic area, then the gangrenous sloughing occurs. We felt in one case that if we could get rid of the toxic area we could eliminate the woman's toxemia, and following the removal of the slough that patient improved and recovered. The outstanding thing is that we, as laryngologists, have been prone to use arsphenamin when we see a case that resembles Vincent's angina. The noticeable fact is that on looking through the literature we are forced to wonder whether the arsphenamin has not precipitated the trouble. We have been watching and trying to follow out the careful use of arsphenamin in the treatment of Vincent's angina, for we feel that we might be instrumental in pre-

cipitating this type of angina. We removed the membrane simply by evulsion, very gently.

DR. AUSTIN A. HAYDEN: In the last nine years I have seen I do not know how many cases of agranulocytic angina, but in the last eighteen months I have seen eight cases. I think every man in the room has seen more of these cases than he realizes. Up to the time that Schultz published his first paper I think the last thing that the nose and throat man or the general practitioner thought of in the care of any sort of ulcerative stomatitis was making a blood count. He made a culture immediately but not a blood count. This question has brought very much to the front the necessity of making blood counts, especially white blood counts, in cases with any sort of ulcerative lesions of the nose and throat, especially of the throat. Of the eight cases I have seen, seven patients are dead. The only patient I have seen who is alive is one I saw in consultation with Dr. Frank Novak, and there was some question as to whether it was really an agranulocytic angina.

That brings up the question of what cases are to be classed as this disorder. How low must the white count go before you have some trouble with the resistance the white cells offer? All of the patients who died in our series had a white count lower than 500. I think a white count lower than 5,000 needs a very guarded prognosis. One lower than 1,000 should have an unfavorable prognosis, and under 500 the prognosis is extremely grave. In this series there were two men and six women, all past middle life. The one case that recurs to my mind most vividly occurred in the wife of one of the members of the staff at St. Joseph's Hospital. I will recite the history very briefly.

About four weeks before this patient developed the angina she had had a tooth removed, and her husband was much incensed at the dentist for sewing the cavity up. It healed without much trouble but some soreness remained. In the morning this physician went out into the country, the day after he called me to look at his wife's throat. She then seemed to be perfectly well. Whether her blood count was up or down at that minute I do not know, but I suspect, in view of the fact that we have seen these blood counts change very rapidly when taken four or five times a day,

that her blood count at that time showed very little. Her husband suspected that she had an involvement of the antrum, and I was asked to pass on that subject. Instead of an antrum involvement, I found that she had a well marked membrane on her left tonsil. A culture was made, which showed Klebs-Loeffler bacilli. Instead of healing, that abscess persisted. We made a blood count and found less than 500 white cells. Within a period of forty-eight hours she was dead, in spite of the fact that she was transfused twice and was given enormous doses of diphtheria antitoxin.

To sum up, I think the things that stand out are the prevalence of syphilis, the rapidity with which the white blood count can go up and down, and the occasional history of tooth infection. When I first came to Chicago I shared an office with an extraction specialist, and I know that some of his patients died with a throat infection. Whether it was agranulocytic angina or not I do not know, but a blood count would have been in order.

DR. ALFRED LEWY: I wish to report a case, with recovery. The patient was a woman of middle age, who was taken with what appeared to be a peritonsillar abscess. Blood examination showed the white count as low as 2,100, with less than 7 per cent granulocytes. She continued in that condition for about a week or two, with the granular leucocytes never exceeding 7 per cent, sometimes going as low as 3 per cent, and then recovered. Three months later she had another attack of what appeared to be a peritonsillar abscess, with the same blood findings, and she again recovered. The only treatment she received was roentgenotherapy in suberythema doses.

Some months ago I saw an article reporting twenty-six or twenty-eight cases of agranulocytosis treated with $1/20$ suberythema doses of roentgenotherapy, with approximately 50 per cent recoveries. In our case we used $1/3$ of an erythema dose.

Another case I reported before this society three or four years ago was an agranulocytosis with exitus, in which blood culture revealed the streptococcus viridans. This did not appear for over a week after the culture was taken and I do not know whether it was a contamination or not.

I think the roentgen-ray should be considered in the treatment of these cases. Another thing, particularly in the cases with hem-

orrhage, aside from the granular leucocytes, other cells may be affected, according to the degree in which the cell-forming portion of the bone and marrow may be affected. There may be complete destruction of the bone marrow, as occurred in a case I saw recently in which hemorrhages occurred in the mucous membrane and other parts of the body. The case was diagnosed as pannyelophthisis. At postmortem the medullary portion of the long bone was about the diameter of a lead pencil.

DR. FRANK J. NOVAK, JR. (closing): From the reports we have heard tonight it is evident that many therapeutic measures have been employed in these cases, and it is difficult to put our fingers on any one thing to account for improvement in some of them. Among the radiologists there is a difference of opinion at this time as to whether there is a stimulating dose of X-ray. Without going into that, I wish to mention that among the cases, to which I have referred one patient was a child, aged 4; four were females and two males. The fusiform bacilli were found in each case, as was Vincent's spirilla. In the case Dr. Sweeney mentioned the abscess seemed to have some effect on the progress of the case. We all know that an extensive necrosis of the bone marrow seems to be the underlying pathology in agranulocytosis, but what brings about the necrosis we do not know. It is an interesting fact that while myelocytic elements are formed in the marrow, nevertheless, under certain pathologic conditions, such as repeated bleeding of animals and following the use of various chemical agents, these cells are also formed elsewhere. We find them in the aorta, in the lymph nodes and even in the liver. This is an acute, extramedullary myelopoiesis. If the blood forming elements have been destroyed, perhaps the formation of the abscess in Dr. Sweeney's case with the use of turpentine stimulated production of the granulocytes by other organs until the bone marrow was able to take care of the situation. That, however, is mere speculation.

Dr. Hayden mentioned the rapidity of the appearance and disappearance of the granulocytes in the blood and the rise and fall of the total count. One of our patients who had 1,100 white cells within six hours developed 28,000 white cells, with 80 per cent granulocytes.

DR. T. C. GALLOWAY: Our patient had necrotic lesions over the alveolar ridge, over the tonsils and tongue. There was a lesion over the arytenoids and aryepiglottic folds which was not seen until the first ones began to clear. When she showed the change in the blood picture the other lesions all began to slough and clear except this one. We watched her very carefully, carrying her along with oxygen inhalations, but it became imperative to do a tracheotomy. Now the wound is clean, and there is no sign of the gangrenous condition that there was in the other lesions.

DR. J. P. SIMONDS: We do not know the cause of this condition, but there is one possible way of throwing some light on it. Some patients have recovered. If it is truly a bacterial infection the blood from those patients may contain agglutinins. It would be of value to take some blood from these convalescent patients and do agglutination tests on every organism that is recovered from other patients with the disease. In that way we may be able to get something of value for future use.

DR. A. H. ANDREWS addressed the society on

"Indications for Operation in Acute Mastoiditis."

DISCUSSION.

DR. FRANCIS L. LEDERER: I think we will agree that each case is an entity; we cannot formulate any direct set of rules that will cover all cases. Often it is purely personal experience that guides us in the management of the individual case and makes surgical interference desirable. There are two things to bear in mind: First, the safety of the patient; second, the future of the patient, particularly regarding hearing, prevention of chronicity, and so on. We have all heard of very severe cases that recovered under no treatment at all, and it is therefore difficult to judge operative indications or interference by medical management based on those cases. As long as we can have no actual principle set up, I think, as in every other disease, we should never forget that the underlying pathologic state is the determining factor in governing the management of these cases. We all recognize that indications for operative interference are often dependent upon the ability and temperament of the operator. We have always considered our

indications under three groups, viz., absolute, relative and atypical.

Without going into any evaluation of the symptoms, let us realize that there are variations in cases, viz., seasonal, individual, bacteriologic, anatomic and yearly variations. A case this year will not be the same as one of last year. Much depends upon whether we are dealing with an encapsulated organism or not, and we must consider the individual in every instance.

In the anatomic consideration, I think it is foolish to have a roentgenogram made in the early stage to aid the pathologic interpretation except that it is well to know whether we are dealing with a case in which we can expect an early breaking down (rheumatic) or greater local resistance (diploic).

As to early diagnosis, I think that tenderness at the onset of an otitis has provoked more discussion than anything else, but I am sure we will agree that that is a periostitis and does not form an operative indication. We differentiate between a mastoidism, which is a periostitis, and an empyema, which is really a mastoiditis. The roentgenograms show variations and must be interpreted with a great deal of common sense. We must place the clinical findings ahead of the laboratory findings. I know the finding of a high calcium content in the pus has been considered an indication of the amount of bone destruction, and in some instances it has served to aid in the decision to operate. It is thought that when an otitis media occurs with a mastoid involvement before the age of puberty it interferes with the pneumatization of the mastoid. That was Wittmaack's idea, but I think this has been disproven. We always have to take into consideration in the X-ray examination whether the patient has had a previous attack, which might have altered the cell arrangement.

DR. GEORGE H. MUNDT: The essential thing, as Dr. Andrews and Dr. Lederer brought out, is to visualize what is happening in the mastoid, for the decision as to whether a case is operable depends upon what is in the mastoid. I believe that roentgenograms made after a few days and made in series are very valuable. This does not necessitate a great expense.

If one can feel bone in the débris that is discharged, that also is valuable. Certainly we must take into consideration the gen-

eral condition of the patient. All of us probably have seen patients with an acute suppurative otitis media who are prostrated almost immediately. Many of those patients will have a tremendous discharge from the ear. If this occurs and their general condition is good I think it is thoroughly justifiable to open the mastoid early, although I think it is undesirable to operate early in most cases. If the discharge is so profuse that one finds it difficult to believe that it comes from the middle ear, operation is very important. One must decide in his own mind in the cases of fresh otitis media the period at which he will begin to think seriously of the necessity of operating. I have for a good many years, in the ordinary cases under good management, when the patient does not begin to clear up at the end of two or three weeks, become much disturbed. I appreciate that the time element is a very unscientific thing, but I think there is not a man in the room who does not consider it. I think Dr. Andrews spoke of deafness as a symptom in determining this point. Certainly the patients who become very deaf should think of having something done. I never have looked for the bony débris microscopically. I think the soft tissue change around the tip of the mastoid, brought out by Dr. Andrews, is valuable. It has been my practice for many years to ask patients not to tell me which ear is involved, for I like to examine for myself and think I get a good many valuable points in this way.

About spinal puncture, I have had experiences that made me very dubious about spinal punctures in these patients who have meningismus. I think we can turn a meningismus into a meningitis without much difficulty. If the intracellular septa are broken down it is just as well to operate at once as in three weeks, whether we find this condition by means of a roentgenogram or otherwise.

DR. JOSEPH C. BECK: I have not operated on an acutely infected mastoid for some time, but think I will have to operate tomorrow on a young student who was sent in to me six days after an acute otitis media began. He was very ill with influenza previously and twelve years ago he was treated by me for a double acute otitis media. There was a notation in the old history that he was dizzy for several weeks and that trouble

continued with the right ear. In testing him now he told me that this had been until this last attack, his best ear. Examination with the X-ray shows nonpneumatization of both the mastoids, which possibly is the result of the previous attack of otitis media. I think we should not throw aside the question whether suppuration stops the development of the mastoid, and the sinuses as well, for it has been shown that there is a definite curtailment of development of sinuses and mastoids following infection. The patient to whom I have just referred has marked hearing defects, especially in his best hearing ear, headache and loss of appetite. Those are my indications for operation, especially in the light of the previous history of ear infection.

DR. AUSTIN A. HAYDEN: I think spinal punctures are absolutely indicated and have never seen any harm from them in any case which was in any way suggestive of intracranial involvement. I also think caloric tests are far more important than measuring the bone conduction.

A high leukocyte count with a high percentage of polymorphonuclears is of extreme value in the absence of other inflammations in the body that will account for such a count. I feel also that a Schilling shift to the left is a very important thing.

Also, I feel that roentgenograms, even though expensive, are well worth while, and that the early picture is of tremendous importance in these cases, perhaps not from what it shows but from the basis that it establishes for comparison with subsequent pictures which indicate the bone change.

In regard to the tenderness being due to a periostitis and not to bone involvement, it seems to me that barring the presence of furunculosis and such things it is extremely difficult and quite hazardous to attempt to distinguish between those two conditions.

DR. A. H. ANDREWS (closing): I agree with Dr. Hayden that if roentgenograms are to be of the greatest value they should be taken early and be repeated as the disease progresses. I further agree that all cases of postauricular periostitis come from conditions within the bone and not from external causes. Periostitis occurring in suppurative otitis points strongly in the direction of mastoid surgery.

I was surprised to hear the statement that spinal puncture never does any harm. When the patient's condition grows worse after spinal puncture I know of no way of determining positively what his condition might have been without the spinal puncture. Dizziness is undoubtedly an important symptom suggesting the possibility of labyrinthine involvement.

Dr. Mundt remarked that it is important to know what is happening inside the mastoid. This is true, but it is just as important to know what is happening just outside the mastoid: i. e., in the internal ear, the brain and the lateral sinus. Pain coming on after the patient should be improving should be a strong indication for operative interference.

My method of transillumination is very simple. I use a small fountain pen flashlight. With a speculum pushed rather deeply into the auditory canal with the room darkened the flashlight is placed well back on the mastoid. Then the posterior wall of the auditory canal should be observed to see if it becomes illuminated. The only light reaching the posterior wall must go through the bone. If the bone is diseased less light will go through than if it is normal.

The safety of the patient is always the first thing of importance. In his interests the indications for an operation should be influenced to a considerable extent by the experience and ability of the operator. If the doctor who is to operate has had little experience, or if his experience has not been very satisfactory, it is his duty to the patient to wait until the operation becomes imperative. Up to a certain point it is better for the patient to take chances with nature than with the inexperienced surgeon. On the other hand, if the doctor who is to operate has had a wide experience and the result of his surgery has been satisfactory he is justified in operating earlier.

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